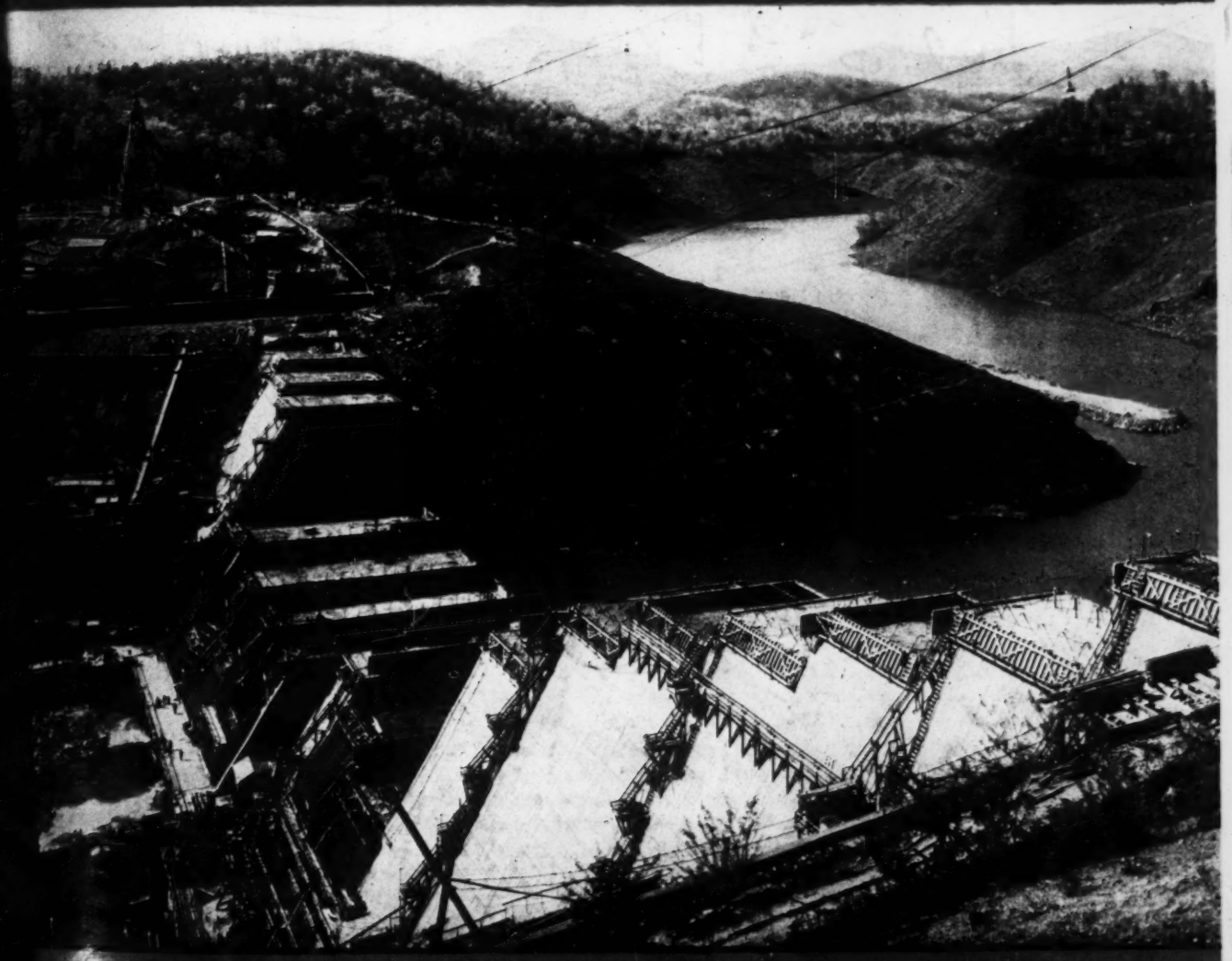
ENGINEERING CONSTRUCTION WEEKLY

SEP 20 1939

ENGINEERING NEWS-RECORD

SEPTEMBER 14, 1939



EFFECT OF WAR ON CONSTRUCTION

An Editorial Statement – see p. 64

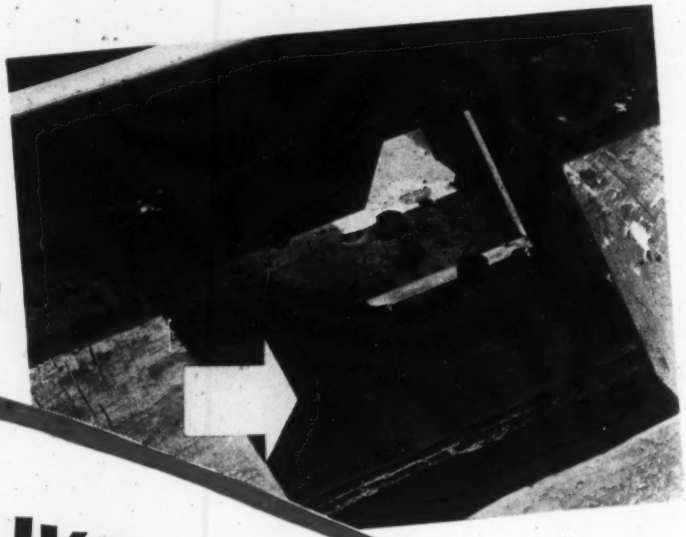
PUBLISHING COMPANY, INC. • TWENTY-FIVE CENTS. FIVE DOLLARS PER YEAR

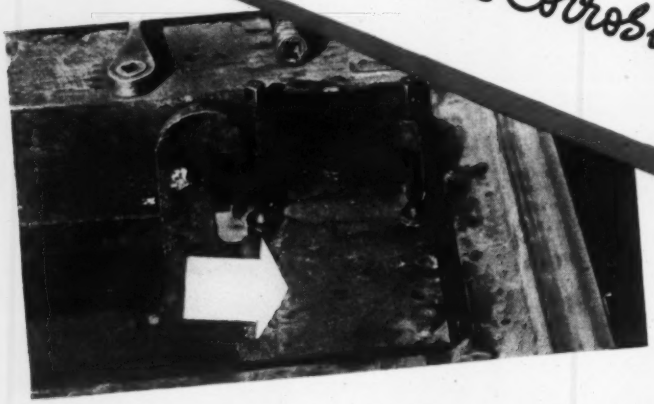
CORROSION COSTS YOU MORE THAN WROUGHT I ON

Bridge Cover Plates of

BYERS WROUGHT IRON

Solved a Serious Brine Corrosion Problem here





Brine drippings from refrigerator cars are highly corrosive. In a long railroad bridge at Kenova, W. Va., the drippings had extensively corroded the top angles of the deck stringers. The railroad quickly and easily solved the problem, with no delay to traffic. 3381 lineal feet of wrought iron plates were welded to the top flanges with 6762 lineal feet of fillet welds. Corrosive attack, previously rapid, was brought under control; and lateral stiffness was added to the floor members.

The use of wrought iron for bridges is rapidly growing. Blast plates, railings, fire and brine protection plates are widely used. But bridge applications are but one of hundreds of places where wrought iron has solved serious corrosion problems, as it can probably solve yours.

If corrosion is causing excessive maintenance or premature replacement anywhere in your plant, structures or equipment, the chances are good that you are losing money not using wrought iron. You can easily find out. Just write, outlining details. Our Engineering Service Department will (1) Determine the probable type of corrosion involved; (2) Relate the conditions to similar conditions encountered elsewhere; (3) Interpret the results in terms of 75 years' contact with corrosion problems; and (4) Make recommendations . . . supported by service records. If you do not have our bulletin, "The Welding of Wrought Iron," write for a complimentary copy.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON

TUBULAR AND FLAT ROLLED PRODUCTS

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals Railroads

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THIS WEEK

● War in Europe cannot but have its repercussions in America. How will it affect the construction industry? At the moment the answer is anybody's guess. However, there are important factors that indicate that the effect will be significant. These are summarized in an editorial statement beginning on p. 64.

● Another big construction job at Panama is in prospect. Congress has authorized construction of a third set of locks and doubtless will put up the money for the start of work soon after it convenes. What is known of the plans and the construction program is given on p. 66.

● Dam construction is far from static. In this issue is given a summary of what is being done at Hiwassee Dam to produce concrete that will be free from cracks.

● Contractors who have government contracts or who may have them some day will find much valuable information in "Final Settlement of Government Contracts," p. 76.

● For sanitary engineers there are three major articles of note, high-speed water purification at Springfield, Ill., experiments in upside-down sedimentation, and the effect of storage on stream purification.

THINGS TO COME

A PORTFOLIO of 1939 Buildings will be a feature of the October 26 issue. From among the many outstanding buildings of the year that have contributed to advance in architectural, structural and mechanical knowledge the editors have selected ten that are particularly worthy of consideration. Each building is of a different type and each will be described from foundation to roof.

WHEN CRANSTON, R. I., largest city in the country without a sewerage system, launched a $6,000,000 program to install these facilities, a rare opportunity presented itself to study 1939 methods of sewer design and construction procedure. A News-Record editor was dispatched to the scene of operations and he reports what he saw and learned in the Sept. 28 issue.

Underneath Chicago—
with RYERSON REINFORCING

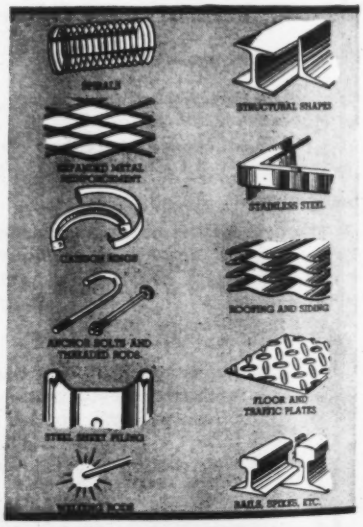
New Subway Moves Ahead On Schedule

• More than 2450 tons of Ryerson New Billet Steel Reinforcing Bars are going into the first stretch of Chicago's new subway now being constructed by M. Pontarelli & Sons. Bars are cut, bent to specifications and delivered ready to set in the form just as needed.

Ryerson Offers Most Complete Service

Ryerson Contractors and Builders service is most complete, including all accessories, wire mesh, caisson rings, removable forms and any miscellaneous steel requirements from structurals to sheets—foundation bolts to welding rod. You can place all steel requirements with this one source with assurance of coordinated shipments that will save you time.

On your next job, ask Ryerson Engineers to work with you. Perhaps they can save you both time and money.



JOSEPH T. RYERSON & SON, Inc.

Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Boston, Buffalo, Philadelphia, Jersey City

RYERSON STEEL-SERVICE

CONTRACTS AND CAPITAL

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	August 1938 (4 wk.)	August 1939 (5 wk.)	% Change†	Eight Months 1938 (34 wk.)	Eight Months 1939 (35 wk.)	% Change†
Total	$231,771	$311,222	+7.0	$1,710,035	$2,049,915	+16.3
Private	45,806	107,859	+88.0	583,873	540,729	−10.0
Public	185,965	203,363	−13.0	1,126,162	1,509,186	+30.0
Federal	50,071	44,189	−29.0	225,221	218,893	−5.5
Total New Productive Capital	$251,457	$380,620	+21.0	$2,738,859	$2,149,740	−24.0
Private Investment	67,387	59,250	−30.0	650,547	577,560	−14.0
Federal (non-federal work)	190,308	14,869	−94.0	944,370	444,152	−54.0
Federal (federal work)	−6,238	306,501	.....	1,143,942	1,128,028	−4.0
FHA Mortgages Selected for Appraisal	$104,227	$98,483	−6.0	$653,640	$785,070	+20.0

†Adjusted for difference in number of weeks.

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	September 1938	September 1939	% Change	Change August to September: 1938 Aug.	1938 Sept.	1938 %	1939 Aug.	1939 Sept.	1939 %
ENR Construction Cost Index, 1913 = 100	232.70	234.97	+1.0	232.39	232.70	+0.1	234.90	234.97	0
ENR Building Cost Index, 1913 = 100	194.80	196.61	+0.9	194.49	194.80	+0.2	196.54	196.61	0
ENR 20-CITIES' AVERAGE									
Common Labor	$0.677	$0.685	+1.2	$0.677	$0.677	0	$0.685	$0.685	0
Skilled Labor (Av. 3 Trades)	1.426	1.444	+1.3	1.426	1.426	0	1.444	1.444	0
Bricklayers	1.519	1.538	+1.3	1.519	1.519	0	1.538	1.538	0
Struct. Ironworkers	1.473	1.499	+1.8	1.473	1.473	0	1.499	1.499	0
Carpenters	1.288	1.296	+0.6	1.288	1.288	0	1.296	1.296	0
Cement, per bbl.	$2.57	$2.60	+1.2	$2.58	$2.57	−0.4	$2.60	$2.60	0
Reinforcing steel, per cwt.	2.48	2.42	−2.4	2.51	2.48	−1.2	2.44	2.42	−0.8
Struct. steel, Pitts.	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.24	1.20	−3.2	1.24	1.24	0	1.21	1.20	−0.8
Lumber, 2 x 4 Fir, per M ft.	31.49	32.30	+2.6	31.24	31.49	+0.8	32.30	32.30	0
Lumber, 2x4 Pine, per M ft.	28.15	28.62	+1.6	27.88	28.15	+1.0	28.50	28.62	+0.4
Brick, common, per M	13.86	14.22	+2.6	13.86	13.86	0	14.23	14.22	−0.1
Ready-mixed concrete, c.y.	7.12	7.10	−0.3	7.14	7.12	−0.3	7.10	7.10	0
Struct. Clay Tile, 3x12x12	74.24	74.27	0	74.24	74.24	0	74.27	74.27	0
Paving Asphalt, cars, ton	15.44	13.77	−10.8	15.38	15.44	+0.4	13.88	13.77	−0.8

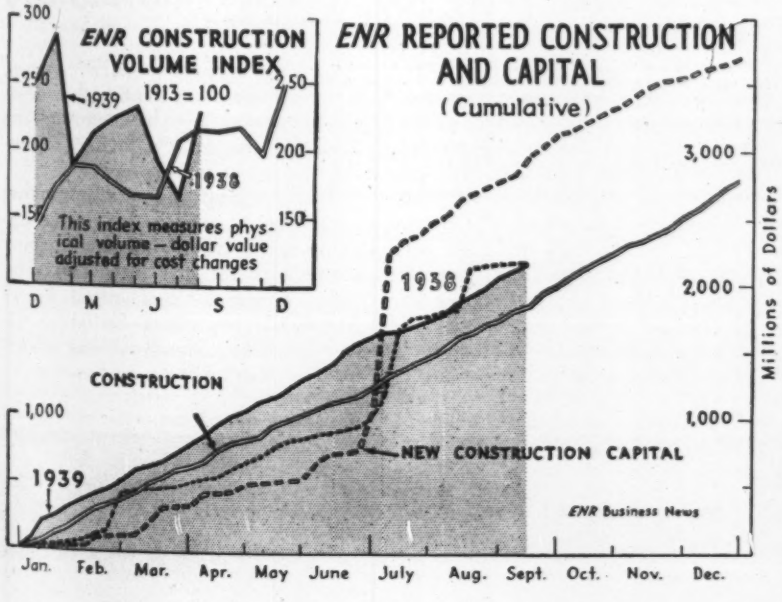
MATERIAL SHIPMENTS . . . BUILDING PERMITS

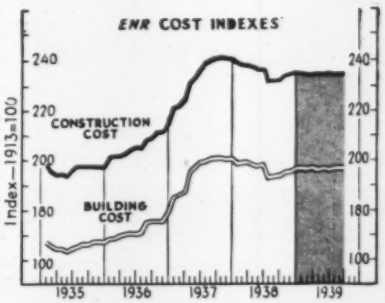
	August 1938	August 1939	% Change	July 1939	% Change July-Aug.
Lumber (% 1929 wk. seas. av.) N.L.M.A.	66.3	71.0	+7.1	67.3	+5.5
Steel (% operating capacity) A.I.S.I.	40.6	61.3	+50.9	51.3	+19.5

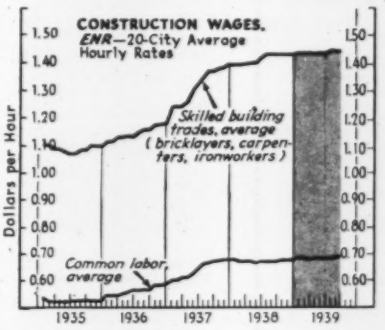
	July 1938	July 1939	% Change	Seven Months 1938	Seven Months 1939	% Change
Fabricated Struct. steel, tons, A.I.S.C.	87,992	104,393	+18.8	655,247	775,220	+18.3
Cement, thous. bbl., U.S.B. of M.	10,164	11,755	+16.1	55,774	66,022	+18.4
Building Permits, Dun & Bradstreet, (,000 omitted)	$140,804	$102,750	−27.0	$668,364	$724,140	+8.3

RENT INDEX . . . EMPLOYMENT

	July 1938	July 1939	% Change	June 1939	% Change June-July
Rent (Housing) Index, N.I.C.B.	86.6	86.3	−0.3	86.0	+0.3
All Trade Unions, % Employed, A.F.L.	82.0	88.0	+7.3	89.0	−1.1
Building Trades, % Employed, A.F.L.	65.0	76.0	+16.9	78.0	−2.6






CONSTRUCTION WAGES,
ENR—20-City Average Hourly Rates
Dollars per Hour
Skilled building trades, average (bricklayers, carpenters, ironworkers)
Common labor, average
1935 1936 1937 1938 1939

CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 15 1938	Sept. 7 1939	Sept. 14 1939
Federal	$9,304	$6,290	$13,012
State & Municipal	36,113	32,329	23,624
Total public	$45,417	$38,619	$36,636
Total private	8,152	13,387	13,836
TOTALS	$53,569	$52,006	$50,472
Cumulative 1939 (37 weeks)			$2,152,393
1938 (37 weeks)			$1,868,279

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 37 Wk.	1939 37 Wk.
NON-FEDERAL	$1,847,969	$1,027,692
Corp. securities	325,577	175,589
State & Mun.	418,132	407,791
R.E.A. loans	13,543	89,445
R.F.C. loans	97,391	4,015
P.W.A. allot.	589,019	.....
U.S.H.A. loans	202,807	160,852
Fed. Aid—Hwys.	201,500	190,000
FEDERAL	$1,144,098	$1,128,028
TOTAL CAPITAL	$2,992,067	$2,155,720

FHA MORTGAGES

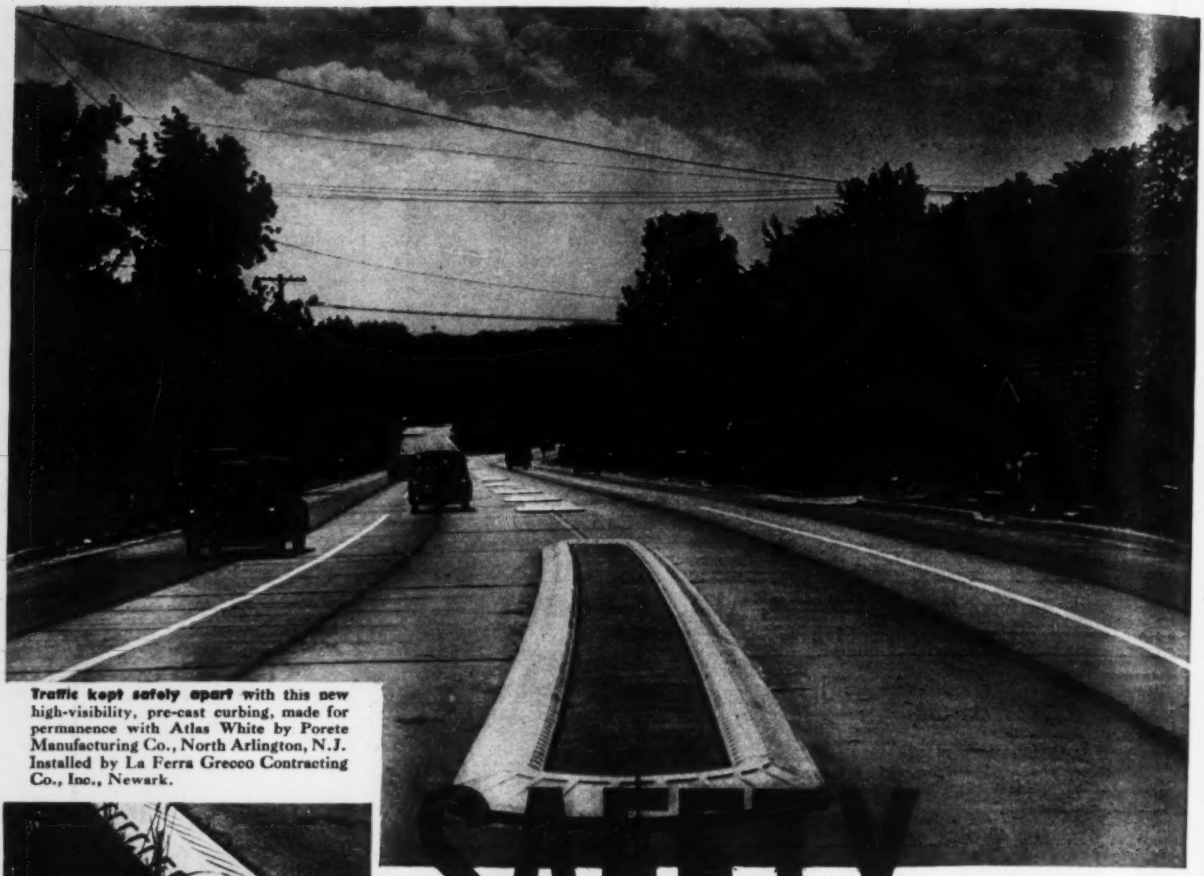
	Week Ending Sept. 10 1938	Sept. 2 1939	Sept. 9 1939
Selected for appraisal	$19,368	$22,386	$17,289*
Cumulative 1939 (36 weeks)			$806,062*
1938 (37 weeks)			$689,532

* Subject to revision.

ENR INDEX NUMBERS

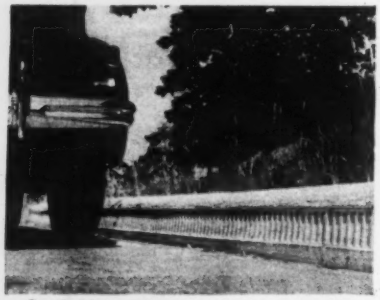
Base = 100	Construction Cost 1913	1926	Building Cost '13	'26	Volume '13	'26
Sept., 1939	234.97	112.95	196.61	106.28	...	...
Aug., 1939	234.90	112.92	196.54	106.24	228	100
July, 1939	234.94	112.94	196.78	106.37	166	73
Sept., 1938	232.70	111.86	194.80	105.30	213	93
Aug., 1938	232.39	111.71	194.49	105.14	215	94
1938 (Av.)	235.86	113.34	196.83	106.40	197	86
1937 (Av.)	234.71	112.66	196.15	106.07	172	75
1936 (Av.)	206.42	99.15	172.18	93.14	185	81
1937 (Av.)	196.44	94.43	165.76	89.65	134	59

August Construction Table on page 59.



Traffic kept safely apart with this new high-visibility, pre-cast curbing, made for permanence with Atlas White by Porete Manufacturing Co., North Arlington, N.J. Installed by La Ferra Grecco Contracting Co., Inc., Newark.

Close-up view of pre-cast center curbing shows how new vertical-faced ribs are designed to reflect car lights back so motorists can see the complete outline of the curb . . . even in extremely bad weather.



Road-side curbing also has new vertical ribs to reflect light. This curbing was cast in place. Made with Atlas *White*, it will keep its bright white appearance without painting or replacing—for years and years.

SAFETY ON THE OPEN ROAD

with curbing of white concrete

ON New Jersey's traffic-filled Route 29, millions of motorists today travel with greater safety. That's because the new type pre-cast curbing you see above increases visibility for day *and* night driving.

Why is this new curbing so successful? Because it's designed with vertical-faced ribs that increase night visibility by reflecting car lights back toward motorists. And because it's made with Atlas White portland cement that increases visibility in all sorts of weather . . . and that does so *permanently*—thus ending the need for frequent painting, repairing and other upkeep costs!

Plan to keep your traffic moving smoother . . . safer . . . at lower upkeep costs—with this new curbing made with Atlas White. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

NR-M-6

ATLAS **WHITE** PORTLAND CEMENT FOR MARKERS AND CURBS

ENGINEERING NEWS-RECORD

Volume 123 SEPTEMBER 14, 1939 Number 11

War Role Studied For Federal Works

Administrator Carmody says his organization could handle huge construction program

Construction agencies of the federal government have not yet been included in the intensive study underway for the past few months in Washington of means to cushion the shock of war on our national economy, to maintain our neutrality, and to prepare for the possibility of involvement in the war. These agencies however are now beginning to work out the parts they will play. It is significant that Federal Works Administrator Carmody attended a cabinet meeting for the first time on Sept. 7.

Carmody points out that agencies included in FWA would undoubtedly form in wartime the nucleus for a number of essential activities. PWA, with its nationwide field engineering staff and contacts with thousands of contractors, could quickly change from a financial to a construction agency. The flexibility of WPA would adapt it to quick construction of barracks and encampments and to rehabilitation of railway lines. The USHA staff has experience that would be valuable in construction of emergency housing, while the Public Roads Administration would unquestionably be called upon to eliminate bottleneck points interfering with truck transportation.

WPA adjusts work to war

WPA is already making changes in its program as a result of the European war. It is planning its volume of employment on the assumption that the war will eventually provide many new jobs but that the immediate effect will be increased unemployment. Type of project moreover is being adjusted to the war situation by an emphasis on defense work for the Army and Navy as well as on construction of highways and airports.

Legality of Dam Authority To Be Decided Sept. 19

The legal status of the Grand River Dam Authority is to be argued in the federal court at Tulsa, Okla. on Sept. 19, where the Authority has begun condemnation suits.

Harvey Langley, of Pryor, Ark., attorney for three land owners, contends that the federal power commission at Washington, D.C., has no right to issue a license to the Grand River Dam Authority because the Grand River is not navigable and does not affect navigability of any other streams. Thus, he claims, the federal court had no jurisdiction in the matter, but that it is one for the state court to adjudicate.

R. L. Davidson, chief counsel for the Authority, relied upon the testimony of Grant Foreman, Muskogee historian, to prove that the Grand River was navigable and subject to government regulations and jurisdiction. Foreman traced the history of the Arkansas as well as the Grand River from 1800 to the present day.

• • •

Railroad Bridge Damaged; Engine Drops Into River

About 100 ft. of the bridge across the Piscataqua River near Portsmouth, N. H., on the Boston & Maine R. R. was demolished Sept. 10 as the locomotive and first car of a southbound train plunged into the river. Two of the locomotive crew were killed but no passengers were injured.

The accident is believed to have been caused by pier subsidence due to the sinking of large caissons nearby in preparation for a new highway and railroad bridge over the river. Investigation showed that the support of one of the 80-ft. spans damaged was displaced before the train came on the bridge. The structure is a draw bridge and an attendant is on duty at all hours. No evidence has been found that would lead to a suspicion of sabotage, according to railroad officials.

Federal Agencies Find No Cost Increase

Contractors have not increased bids because of uncertainties due to war situation

Federal construction agencies have noted little or no tendency on the part of contractors to increase the contingency item in their bids as a result of the uncertainty arising from the war situation or, in recent months, the expectation of war. This is the more surprising because none of the contracts let by these agencies contain any escape clause to protect the contractor in the event of war-caused increases in costs or shortage of labor. Under existing contracts, in fact, even if this country becomes involved in war the contractor is not relieved of any obligations, with the possible exception of liquidated damages for delay. It should be remembered, however, that at the end of the last war Congress passed a "Contractors Relief Act" providing compensation for losses suffered as a result of the outbreak of war.

The Public Buildings Administration, which has scheduled contract lettings totaling about $45,000,000 over the next few months, has no present intention of deferring any bid calls because of the uncertain situation. PBA feels its best contribution to cushioning the shock of the war is a policy of "business as usual." Especially since costs

(*Continued on page 54*)

• • •

Airline Union Station Planned for New York

Work on the construction of a $6,000,000 air terminal on Park Ave. between 41st and 42nd Sts., New York, is scheduled to begin next week. The building will be used as the city terminus for five major air lines, namely, American Airlines, Eastern Airlines, Pan-American Airways, Transcontinental and Western Air, Inc., and United Airlines.

Engineer Asks $82,000 From Bridge Authority

Elbert M. Chandler, president of the Oregon-Washington Bridge Co. of Olympia, filed claims totaling $82,000 last week with the Washington State Toll Bridge Authority for work allegedly done by himself and others to promote the $6,000,000 suspension bridge now under construction across The Narrows near Tacoma.

He asked $66,000 for his own work in drafting plans and making studies on the Tacoma bridge before the toll bridge authority was formed to take over the project. The claim also includes $1,284 for the General Construction Co. of Seattle, $101 for Homer O. Blair, Tacoma engineer who died recently; $500 for Bertha K. Landes, Seattle, for work done by her late husband on a geological survey; $2,043 for B. P. Thomas, Tacoma civil engineer; $1,500 for Robert L. Carter, Olympia civil engineer; and $10,000 for Charles T. Peterson, Tacoma, attorney for Chandler.

Members of the Authority unofficially stated that they did not believe Chandler had any claim against the Authority because it had not asked him to do the work nor used any of his data or findings.

• • •

Costs Not Increasing

(Continued from p. 53)

have not yet started to rise or contractors to become apprehensive.

If costs rose markedly, of course, parts of the building program would have to be dropped to stay within the funds available. PBA is required by law to make firm contracts and therefore could not insert an escape clause even if it wished to do so.

The USHA Situation

Rejection of bids in the past month on four U. S. Housing Authority projects (at Covington, Ky., Asbury Park and Perth Amboy, N. J., and Washington, D. C.) is not considered by USHA as indicating expectation by bidders of rising costs. Administrator Straus points out that contracts have been awarded on 46 projects in the past six weeks—far more than in any previous similar period. Moreover, with more experience behind them, USHA engineers are making their estimates much more closely.

If any marked increase in costs occurred it would, of course, put an immediate stop to the housing program since USHA projects are limited by law to certain maximum costs.

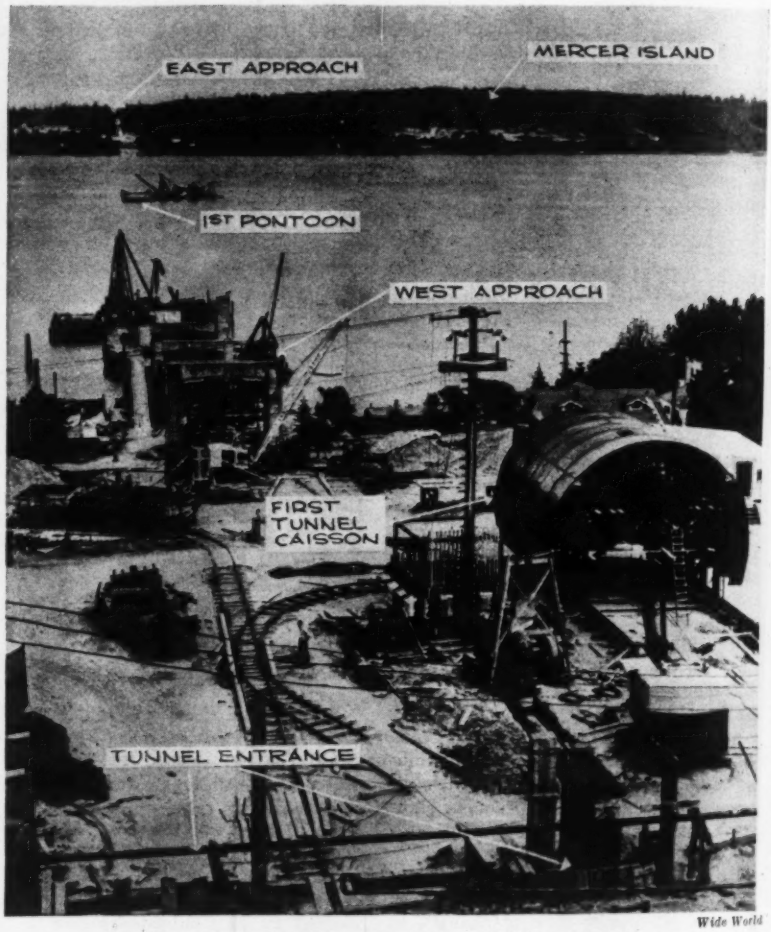
As the law stands even the city would not be allowed to assume any extra costs.

Bid Openings Postponed For Tunnel and Dam

Opening of bids for Friant Dam, of the Bureau of Reclamation's Central Valley Project has been postponed from Sept. 7 until Sept. 14. Because this latter date would coincide with the date for opening bids on the Colorado-Big Thompson Tunnel, the tunnel bid opening has in turn been postponed to Sept. 21.

Two hours before the bids for the dam were to be opened, the Department of Labor increased the wage rates on seven skilled labor classifications. As a result of this unexpected development, Walker Young, in charge of the project, was instructed by telephone to return the bids unopened.

The incident is expected to raise a question, for either administrative or legislative determination, as to the time limit on prevailing wage determinations by the Department of Labor. The department maintains that prevailing wages can be determined at any time until the contract is awarded, while the construction agencies, for obvious reasons, would like to see wages set at their final figure the time bids are called.



Wide World

SEATTLE PONTOON BRIDGE TAKING FORM

WITH THE FIRST of 25 pontoons to be constructed anchored in place, work is advancing rapidly on the $8,000,000 pontoon bridge being built across Lake Washington at Seattle. The pontoon is 350 ft. long by 60 ft. in width. It is made of reinforced concrete and held in place by two anchors weighing about 70 tons each.

In the immediate foreground as shown by the arrows will be the entrance to the tunnel to carry traffic from the west end of the bridge under the Mount Baker bluff to the center of Seattle. Traffic headed the other way upon reaching Mercer Island will cross the island and then a second bridge to reach the east shore of the lake.

Charles E. Andrew is consulting engineer for the Washington Toll Bridge Authority, builders of the bridge; Richard B. Barber, resident engineer, and R. M. Murray, bridge engineer. George A. Gregory is project engineer for PWA, and L. R. Durkee is chief resident engineer inspector.

Fuse Failure Prevents Damage to Bridge

The reports that several sticks of dynamite were found strapped to the abutment of the newly-constructed bridge over the Juniata River on the Pennsylvania superhighway near Bedford Springs "some time in August" have been verified by the Turnpike Commission. The dynamite had been capped, fused and lighted, but failure of the fuse prevented damage to the structure, it is reported.

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Ickes Approves Changes For Marshall Ford Dam

Secretary of the Interior Ickes has approved the change order whereby the contract held by Brown & Root, Inc., and the McKenzie Construction Co., contractors for the dam, was amended to provide for making Marshall Ford Dam a high, flood-control dam.

The original contract, awarded Dec. 3, 1936, called for construction of a low dam with a maximum height of 190 ft., the dam to be enlarged ultimately by widening the base and bringing the crest up to a maximum height of 270 ft. above the foundation, providing a reservoir of 3,120,000 acre-ft.

The Bureau of Reclamation recommended increasing the quantities of various items of work specified in the original contract in order to have the present contractor bring the full base of the high dam to elevations approximately the same as the crest elevations of the low dam. Additional work involved in the change order includes the pouring of about 325,000 cu. yd. of concrete and is estimated to cost approximately $2,574,000. When this work is completed, there will still remain the work of raising the entire dam something more than 70 ft. to complete the high dam.

The project is one of a series of structures comprising the Colorado River of Texas flood control and power project, Marshall Ford Dam being under the Bureau of Reclamation supervision and the other units under the jurisdiction of the Lower Colorado River Authority, a Texas agency.

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Toll Bridge in Indiana Offered for Sale

The Harmony Way Bridge Co. has offered to sell the Wabash River Bridge at New Harmony, Ind., a toll structure, to the state government. The proposed sale price has not been revealed.

Photo by Milton J. Washburn

BUFFALO SEWAGE TREATMENT PLANT DEDICATED

DEDICATION OF BUFFALO'S sewage treatment works on Sept. 12 officially placed in operation one of the major pollution abatement projects on the Great Lakes. The treatment works and additional sewers cost about $15,000,000, part of which was financed with a PWA grant and loan.

The new 150 mgd disposal plant provides partial treatment by means of sedimentation and chlorination. Sludge will be partly digested, filtered and then incinerated. The incinerator, an important plant unit, is of the flash-drying type, and will employ four burning units, each of 100 tons capacity.

Greeley & Hansen, of Chicago, were the consulting engineers for the Buffalo Sewer Authority whose members are Daniel H. McCarriagher, chairman; Henry W. Keitzel, vice-chairman; Myron G. Lehman, secretary; Christy J. Buscaglia, and George W. Lennon. Edward P. Lupfer is directing engineer and Harold Epstein is general manager of the authority.

Complete design details of the Buffalo installation were given in *ENR* issues of Sept. 24, 1936, p. 438, and Aug. 18, 1938, p. 197.

New York Housing Dispute Settled

Straus recognizes city's higher living cost in raising income limits

Income limits for tenants in New York's low-rent housing projects have been adjusted for all but one size apartment in recognition of the city's high living costs, according to an announcement by Nathan Straus, USHA administrator. These adjustments are a result of controversy between Straus and New York's housing authority chairman, Alfred Rheinstein. Rheinstein had stated that he was having a hard time finding families in the lowest one-third income group who were able to pay the rents prescribed.

The top income of the lower one-third in New York is $1,399. The old income limits ranged from $762 to qualify for a two-room dwelling unit to $1,399 to qualify for a six and one-half room unit. New limits are $962 for two rooms to $1,399 for both five-and-a-half and six-and-a-half room apartments. The original New York City Housing Authority proposal outlined a range in income limits of $1,040 to $1,943.

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USHA Reduces Rents On Former PWA Projects

Continuing to scale down the rentals charged on the projects it inherited from PWA's old housing division, the U. S. Housing Authority last week put into effect a rental schedule at Will Rogers Courts in Oklahoma City which reduces the average monthly shelter rent per dwelling from $18.74 to $10.81. Whereas formerly tenants were accepted with incomes as high as $1,969, the highest permissible income will now be $1,065 for a family of seven. Present tenants who cannot meet the new income requirements must move out within a year.

When USHA was created it took over from PWA 48 housing projects which were financed on the basis of a 45 per cent grant and repayment from income of 55 per cent of the cost. Total cost of the projects was $134,000,000.

At the time of the transfer rentals sufficient to make the repayment had been set on twenty of the projects. With the transfer, however, the repayment obligation was wiped out, and USHA was directed to set rents at a level which would meet operation and maintenance costs, payments in lieu of taxes, and "such additional amounts as the authority shall determine are consistent with maintaining the low-rent character of the projects."

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

THE DECISION of the Bureau of Reclamation to carry on clean-up work at Boca Dam on the Little Truckee River in California by force account (*ENR*, Aug. 31, 1939, p. 254) has met with no opposition from the CIO group which prevented CCC labor from being used on the work. Most of the labor now employed at Boca by the bureau is affiliated with the CIO. Labor employed on force account work of the bureau is hired by the bureau's local representative from lists of certified workers furnished by the civil service commission; common labor is ordinarily certified upon presentation of a statement of experience.

AT THE TIME of the strike on Reclamation's Colorado-Big Thompson project rumors were circulating that the bureau's engineers opposed unionization of the job. When these reached Secretary of the Interior Ickes he phoned Commissioner of Reclamation Page, then in Denver, and told him that if any such attitude existed it ought to be "straightened out." In particular, Ickes does not feel that local labor should have a monopoly of employment on reclamation projects, pointing out that the benefits should be as widely spread as possible and that unemployment is greatest in the cities.

FEDERAL BUILDING CONSTRUCTION valued at about $23,000,000 in the District of Columbia is seriously delayed by the continued strike of workers at the Smoot sand and gravel plant; Smoot is the only large supplier in the capital area. Excavation has been completed on the $14,250,000 Social Security Building, and placing of concrete piles —the next step—is prevented by the aggregate shortage. A similar situation prevails at the General Federal Office Building, though some excavation is still underway. Delay on this building is particularly serious because it will be used by the Bureau of the Census in the approaching 1940 census. The $5,000,000 Printing Office Annex is nearly complete, but plastering has been halted by a lack of sand.

AS ONE OF ITS first coordinating activities, the new Federal Works Agency is collecting statistics which will enable it to predict the volume of purchases to be made over the next year or more as a result of the activities of its component agencies—PWA, WPA, PBA, PRA, and USHA. It is felt that this will enable manufacturers to estimate their markets more accurately. Late this month or early in October, Administrator Carmody will hold a conference of industrialists at which the first results of the study will be presented. The statistical work is being done by George W. Babcock, FWA management engineer, who came with Carmody from REA. Babcock is not building a staff but instead is working with one assistant collecting data prepared by statistical agencies already in existence.

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Sewage Disposal System Proposed for Portland

A $10,000,000 sewage disposal project—with intercepting sewers and a partial treatment plant to discharge effluent into the Columbia River—has been recommended to the City Council of Portland, Ore. by a special board of consulting engineers. Sewer extensions costing $7,900,000 and a sedimentation plant to cost $2,400,000 are the major improvements recommended.

This plan, the board claims, would be cheaper by $390,000 than the activated sludge treatment which was initially proposed. It is said also that charges based on sewer use as now set up would not meet the demands necessary to finance the program, the user charge providing only $275,000 annually to offset the $794,000 annual cost. The engineers consider that the plan of building the system a unit at a time, as the money is collected from the user charge, is unsound for the reason that it would not begin to produce the revenue necessary to finance the project.

Members of the consulting board are R. H. Corey, Portland consulting engineer; Wellington Donaldson, chief engineer, New York City bureau of sewage disposal; Carl E. Green, sanitary engineer, Oregon state board of health; and Abel Wolman, consulting engineer of Baltimore, Md.

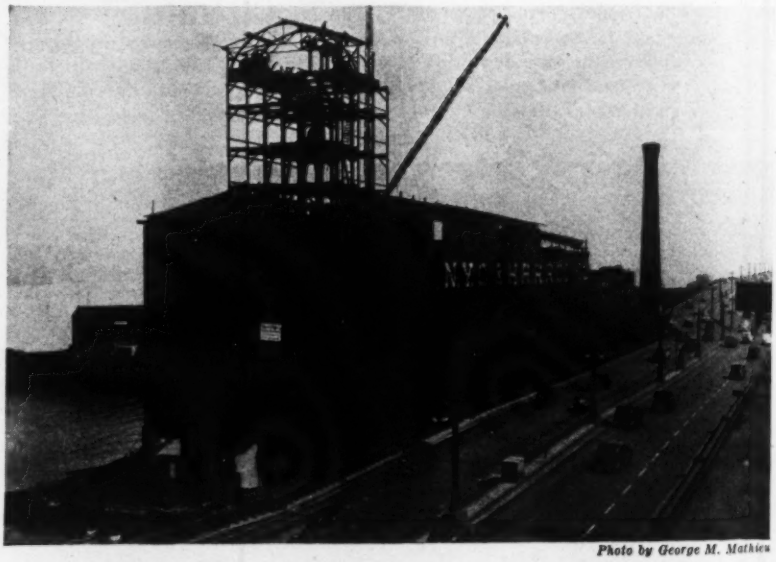

Photo by George M. Mathieu

FIRE HASTENS END OF FAMOUS OLD GRAIN ELEVATOR

A FIRE OF UNKNOWN ORIGIN on Sept. 6 swept through the shell of the old New York Central R.R. grain elevator on the Hudson River waterfront at 60th St., New York, hastening the demolition of the building which was then in progress and putting the West Side Elevated Highway out of service for more than twelve hours.

This picture, taken shortly before the fire, shows the wrecking crews of the Albert A. Volk Co. taking down the wrought iron and timber frame of the headhouse which surmounted the storage bins and rose to a height of 152 ft. above the street.

The elevator was built in 1889. Except for the headhouse and the exterior shell it was largely of timber, the walls of the 70-ft. high bins being made 2 x 8 and 2 x 6 in. plank laid flat, all being supported above the loading tracks on a framework of 12 x 12 in. timber. This timber structure was framed independent of the exterior walls which are of brick up to the bottom of the bins and of hollow tile above that point. It was this solid wall surrounding the timber bins that impeded the fire fighting.

The elevator had a capacity of 1,500,000 bu. It is being taken down as part of the reconstruction of the New York Central freight facilities on the New York West Side. J. W. Pfau is chief engineer and H. T. Welty engineer of structures.

Construction Continued On Havre de Grace Bridge

Progress on the construction of the new highway bridge over the Susquehanna River at Havre de Grace, Md., will not be affected by the disappearance of Robert C. Reitz, of Lancaster, Pa., contractor on the substructure who has been missing since Aug. 19. At the request of the Maryland State Roads Commission, the Hartford Accident Indemnity Co., which issued the surety for the $969,000 contract, has agreed to let the organization set up by Reitz at the job carry on the construction, for a time at least, to avoid the delay of calling in a new contractor. Both the bonding company and the commission are reported to be satisfied with the ability and progress made by this organization. The commission has released part of the retained percentage to meet immediate payrolls.

Reitz was known to have personally carried the payrolls in cash to both the Susquehanna job and another project he was building at Port Jervis, N. Y. He disappeared enroute to Port Jervis with, it is believed, a substantial cash payroll. He is the sole owner of his company, and so far checks of his accounts have failed to reveal anything wrong. Police authorities believe he met with foul play, though no trace or clue to his disappearance has been found.

The new bridge is a high level structure 7,618 ft. long. Substructure work includes two abutments and 52 piers.

Storm Halts Construction In Central Arizona

A heavy rain storm, said to be the worst in 28 years, struck Central Arizona last week destroying many buildings and washing out highways and railroads. Flood waters from cross drainage broke through the main canal of the Salt River Valley project, flooding farms to the north of Phoenix.

Highways leading to California were flooded, traffic being at a standstill; the road to Boulder Dam was open only to light traffic, and the transcontinental highway across northern Arizona was closed for an indefinite period of time west of Kingman.

Construction work on the power line from Phoenix to the Parker Dam was suspended, as more than three inches of rainfall in 24 hours was recorded in Phoenix; nearly every basement in the city was flooded.

The storm missed the principal storage reservoirs in the state, Bartlett Dam gaining only 6,000 acre-ft. and the gain in the Roosevelt reservoir being negligible.

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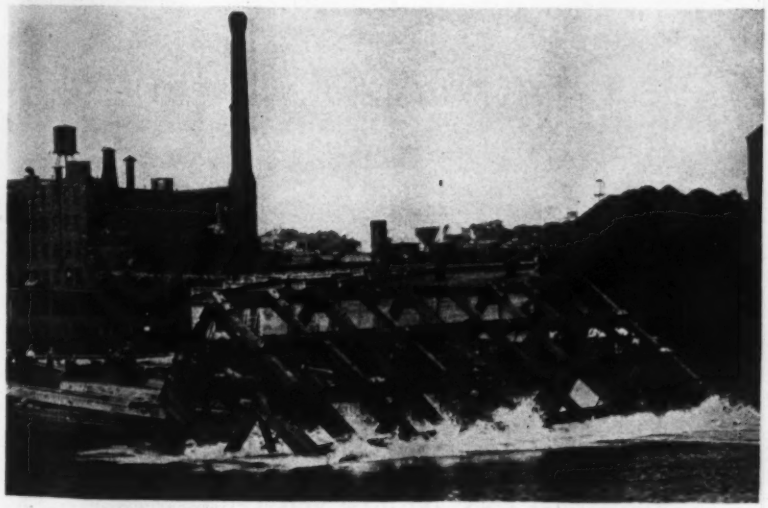
Cave-In Halts Traffic On Oklahoma Road

A settlement of about 1 ft. along a 100-ft. section on U. S. Highway 66 near Miami, Okla., as a result of the cave-in of an old zinc mine has halted all traffic on that thorofare.



LAUNCHING COFFER DAM BRACING FOR MILWAUKEE BRIDGE

ENGINEERS for the Great Lakes Dredge & Dock Co., substructure contractor for Milwaukee's new $550,000 Cherry Street bascule bridge, instead of building the cofferdam bracing for the river piers on the spot, a job that would have been difficult due to river traffic, assembled the frame on the river bank half a block north of the site, rolled it into the water, and floated it downstream into position.

The bridge is being built by the Department of Parks with PWA help. The Milwaukee Bridge Co. has a $150,000 contract for construction of the superstructure.

Carmody Returns PWA Applications

No money available for 5,000 projects estimated to cost more than $1,700,000,000

The Public Works Administration last week returned to local public bodies 5,043 applications for PWA loans and grants on projects estimated to cost $1,749,000,000. These are projects for which no money has been available in past PWA programs, and since Congress passed no public works legislation this year, no further action can be taken on the projects until Congress moves. Of the applications, 3,017 have been examined by PWA examiners.

Analysis of the applications reveals that they cover 17 water power projects to cost $67,128,000; 314 sewerage projects costing $163,000,000; 467 water supply projects totaling $110,000,000 and more than 3,000 buildings.

Return to sponsors of the applications is expected to have little actual effect. In past years, when a PWA program was completed it has been customary to keep applications for which no money was available on file in order to speed the start of the next program. Return of the applications at this time simply impresses on local communities that there is no money for a non-federal works program next year. It may result in their putting some pressure on Congress to provide such a program.

Federal Works Administrator Carmody has expressed the belief that, with cheap credit now available, some of the projects may be carried out privately on a self-liquidating basis. He thinks that material suppliers might form subsidiary corporations to carry out projects as a business-stimulator.

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Thousand Island Bridge Profit $41,807 First Year

A net profit of $41,807 has resulted during the first year of operation of the Thousand Islands International Bridge. During the twelve months 182,373 vehicles were charged for using the structure.

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Home Owners Loan Corp. Reduces Interest Rates

The Home Owners Loan Corp. is to reduce its interest rates to 4½ per cent, effective Oct. 16, according to an announcement by the Federal Home Loan Bank Board. All payments becoming due on or after Oct. 16 will be accepted at the new rate.

OBITUARY

MAURICE FRIEDMAN, retired general contractor, died at Mount Vernon, N. Y. Sept. 7 at the age of 75.

C. A. COOL, Postville, Iowa, former district highway engineer in northeastern part of the state for the Iowa State Highway Commission, died recently.

JOHN E. D. BROWN, 72, contractor of Mooresville, N. C., died there Sept. 7.

WALTER HILLERICK, 61, assistant city building inspector at Louisville, Ky. and former building engineer, died last week. Hillerick served as chief computer for the Interstate Commerce Commission from 1916 to 1922 and joined the Louisville bureau of building regulations in 1934.

GEORGE F. FISK, 62, since 1936 construction adviser to the USHA, died Sept. 4 at Buffalo, N. Y. He received his civil engineering education at M.I.T. and spent the next few years in Cuba. In 1905 Fisk joined the engineering staff of the city of Buffalo. As construction adviser to the government he had been in charge of the erection of the Kenfield, Baker and Lakeview low-cost housing projects.

WOOLSEY H. FIELD, 65, retired civil engineer and financier, died Sept. 8 at Philadelphia. He was educated at Amherst College and soon after graduation went to Cuba to supervise the construction of roads. Field was with the Intelligence Service during the World War.

JAMES THOMPSON, project manager and construction engineer for the Raymond Concrete Pile Co., New York City, died Sept. 8 at Plymouth, Mass. Thompson assisted in the construction of the Pennsylvania R.R. tunnels under the East River at New York City and was connected with the construction of the San Francisco-Oakland bridge.

CHARLES L. NORTON, 69, engineer and director of the division of industrial cooperation at M.I.T. since 1921, died Sept. 8. He was graduated from M.I.T. in 1893 and the same year became a member of the teaching staff.

THOMAS H. RITNER, 42, chief engineer of the W. P. McDonald Construction Co. of Flushing, N. Y., died Sept. 11. After serving in the Engineer Corps during the World War, Ritner was graduated from Penn State College in 1922 with the degree of civil engineer. He had worked as an engineer with the Public Service Production Co., Newark, N. J.; the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; the C. F. McAvoy Co., Newark, N. J., and the North Jersey District Water Supply Commission.

WILLIAM A. SHIELDS, engineer with the Montana State Highway Commission, died recently at Butte. Shields had been connected with the testing laboratory of the commission for the past six years.

J. M. BUCKLEY, 80, former city manager of Pawhuska, Okla., died there Sept. 7. First employed by the city in 1909, he had also served as city engineer.

HOWARD K. BELL, 62, senior member of the firm of Howard K. Bell, consulting engineers, Lexington, Ky., died Sept. 1 at Campbellsville, Ky. After graduating from Georgetown College in 1893 and the University of Kentucky in 1904, Bell worked as chief engineer and manager of the Lexington, Ky. waterworks for four years, spent the next three years in general contracting, and the next eleven years in the design and building of water plants.

M. C. NOBLE, civil engineer of Springfield, Ill., was drowned recently in a canoeing accident in Canada. After graduating in 1916 from Iowa State College with a civil engineering degree, Noble began his engineering work as intrument man on a drainage project of Gukeen, Minn. He was next connected with the county engineer's office of Chickasaw County, Iowa as assistant engineer and later in the same capacity with the Dickinson County office. He served overseas during the World War with the Coast Artillery Corps as first lieutenant. In 1919 he became conected with the Nebraska State department of public works to be in charge of highway construction. In 1923 he was appointed chief of the Bureau of Roads and Bridges of the Public Works Department. He moved to Springfield only recently.

JOHN A. BURNS, 37, superintendent of streets at New Britain, Conn., died Sept. 7 in that city.

JOSEPH C. WATKINS, former city engineer at Iowa City, Iowa, and one time engineer of Dickenson County, Iowa, died recently at Iowa City.

FRANK L. SUPLEE, contractor and builder of Glassboro, N. J., died Sept. 10 at Philadelphia. He was superintendent of building construction and maintenance at the New Jersey state prison farm at Leesburg and a member of the Delaware River Joint Commission.

FELIX JOHN KERSTING, 64, consulting engineer of St. Louis and Kansas City, died Sept. 5, at Jefferson City, Mo. In 1897 he received a B.S. degree in civil engineering and in 1905 a civil engineering degree from the Missouri School of Mines. Kersting had worked on the sewer system of St. Louis as a

TUSCALOOSA LOCK AND DAM BEING COMPLETED

The closure section is now being completed for the Tuscaloosa Lock and Dam being constructed at Tuscaloosa, Ala., on the Black Warrior River by the Mobile District of U. S. Engineers at a cost of $3,000,000 for navigation purposes to replace a series of three old locks and dams immediately upstream.

Concrete placement is by the cableway method and is nearly finished, a total of 165,000 cu. yd. having been needed for the work.

Col. R. Park is district engineer, Capt. G. E. Galloway, area engineer, and Truman A. Smith resident engineer, with Hardaway & Co., Columbus, Ga., the general contractor.

transmitman and was division engineer on the construction of 27 miles of the Atchison, Topeka and Santa Fe Ry. In 1901 he was in charge of the reconstruction of 77 miles of the Jefferson City, Boonville and Lexington Ry., a subsidiary of the Missouri Pacific R.R.

WILLIAM S. GRIGSBY, general building contractor, died recently in Los Angeles.

ROBERT W. FINDLAY, 46, resident PWA engineer of Laramie, Wyoming, died there Sept. 1.

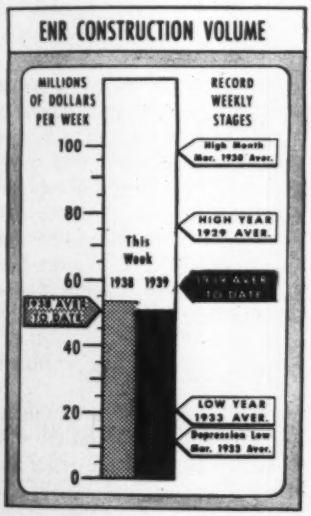
WILLIAM F. FLEMING, 70, director of the city water department of Kansas City, Mo. for 12 years, died Sept. 7. For many years he was head of the Edelman-Fleming Construction Co. and later headed the Fleming-Gilchrist Construction Co.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week total $50,472,000, a decrease of 6 per cent from the volume for the corresponding week last year.

The current week's total brings construction for 1939 to date to $2,152,393,000, a gain of 15 per cent over the $1,868,279,000 reported for the initial 37-week period last year.

Private awards for the week are 70 per cent higher than in the 1938 week due to increased volume in industrial and commercial buildings. Public construction is 19 per cent under 1938.



In the classified construction groups, sewerage construction is at the highest level since Dec. 22, 1938, due to six large lettings totalling $6,091,000 in District of Columbia, Indiana, Michigan, Missouri and New York. In addition to sewerage, waterworks, industrial buildings, commercial building and large-scale private housing, earthwork and drainage, and streets and roads top their volumes for the short preceding week; and industrial and commercial buildings, and earthwork and drainage exceed their respective totals for a year ago.

New capital for construction purposes for the week totals $1,472,000. This compares with $164,023,000 for the corresponding week last year, a very abnormal week. The current week's total is made up of $1,037,000 in state and municipal bonds, $275,000 in corporate security issues, and $160,000 in RFC loans.

New construction financing for the year to date, $2,155,720,000, is 28 per cent lower than the $2,992,067,000 reported for the 37-week period in 1938. (*Weekly Contract Table on page 51*)

Seattle Transit To Be Revamped

RFC advancing $5,700,000 for rehabilitation of system and $4,300,000 for debt retirement

The Beeler Organization, New York transit engineers and consultants, appointed March 29 to survey the Seattle, Wash., municipal transportation system, reported to Mayor Langlie last week in favor of replacing existing street cars and cable cars with trackless trolleys and buses.

The report already has been approved by the Reconstruction Finance Corporation, which is advancing the city $5,700,000 for rehabilitation of the system and $4,300,000 for retirement of old debts. It is now being studied by the Seattle transportation commission, appointed recently by Mayor Langlie, and is expected to be approved shortly with little if any change.

The system now in operation was purchased by the city from the Puget Sound Power & Light Co. during the World War for $15,000,000. Little new equipment has been purchased since that time and the Beeler report described the property as "not only obsolete but practically worn out."

In explaining its preference for trackless trolleys over new-type street cars, the Beeler organization declared that street cars and trackless trolleys provided the same comfort and speed, but that the latter load at the curb.

As the first step in the rehabilitation program, the city transportation commission last week awarded four contracts totaling $227,884 for 1,056,000 lb. of copper trolley wire. J. A. Roeblings Sons Co. will furnish 50,000 lb. and the Bridgeport Brass Co., General Cable Corp. and the Anaconda Wire & Cable Co., 335,000 lb.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN AUGUST, 1939

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Five Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States Aug. 1939	United States Eight Months 1939	United States Eight Months 1938	Canada
Waterworks	594	16,337	523	2,841	962	650	**21,907**	140,042	74,258	704
Sewerage	502	1,955	121	4,757	1,486	624	**9,445**	114,494	68,440	483
Bridges, public	986	5,301	2,005	2,972	1,137	353	**12,754**	110,604	68,352	588
Earthwork and waterways	1,811	779	4,677	72	5,518	18,083	**30,940**	147,778	192,193	1,297
Streets and roads	1,660	16,844	7,253	10,307	12,946	3,547	**52,557**	445,034	397,111	6,638
Buildings, public	4,393	19,845	16,594	13,869	7,463	4,257	**66,421**	441,052	210,370	665
Unclassified, public	57	2,922	2,435	541	1,181	2,203	**9,339**	110,182	115,438	1,443
Total public	**10,003**	**63,983**	**33,608**	**35,359**	**30,693**	**29,717**	**203,363**	**1,509,186**	**1,126,162**	**11,818**
Federal government (included in above classifications)	1,931	4,816	6,856	1,680	7,175	21,731	**44,189**	218,893	225,221	.....
Private										
Bridges, private	.....	950	240	.....	.....	939	**2,129**	4,881	4,593	25
Buildings, industrial	502	6,680	511	13,848	4,564	1,233	**27,338**	140,341	105,453	1,504
Buildings, commercial	2,465	31,577	2,426	5,025	2,262	2,344	**46,099**	258,050	415,350	515
Unclassified, private	475	1,335	2,026	3,106	21,644	3,707	**32,293**	137,457	58,477	180
Total private	**3,442**	**40,542**	**5,203**	**21,979**	**28,470**	**8,223**	**107,859**	**540,729**	**583,873**	**2,224**
Total Engineering Construction										
August, 1939 (5 weeks)	**13,445**	**104,525**	**38,811**	**57,338**	**59,163**	**37,940**	**311,222**	.....	.....	**14,042**
July, 1939 (4 weeks)	6,418	56,630	26,945	35,753	33,930	21,793	**181,469**	.....	.....	21,315
August, 1938 (4 weeks)	14,500	79,640	27,726	25,814	47,110	36,981	**231,771**	.....	.....	6,253
Eight Months — 1939	106,044	675,015	306,965	383,700	71,193	206,998	.....	2,049,915	.....	79,669
Eight Months — 1938	78,422	682,086	166,705	209,283	295,122	278,417	.....	.....	1,710,035	57,264

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Thickened Edge Pavements

Sir: Professor Downs' criticism of the thickened-edge pavement (*ENR*, Aug. 3, p. 154) is in harmony with the conclusions, based on facts developed by research of the U. S. Public Roads Administration as reported last March by E. F. Kelley, chief of the division of tests, at the annual meeting of the American Concrete Institute.

However, the inference that concrete pavement slabs should endure as long as concrete in "bridges and dams" is not fair or logical. The conditions of service are decidedly different. Consider by comparison a thin slab on an uncertain subgrade that in a varying degree continually changes in volume, cracking and heaving because of moisture and temperature conditions. It is at the same time being subjected directly and relentlessly to the pounding of motor vehicles so that defects that develop are accentuated and spread. Certainly concrete in such a structure should not be compared to its disadvantage with concrete in bridges and dams. Nor should too much be expected in overcoming the evils with which it is beset by changing to a section of uniform thickness.

G. F. SCHLESINGER
Engineering Directory
National Paving Brick Association
Washington, D. C.

Welded Rail Joint Study

Sir: In the abstract of the A.R.E.A. Report on Continuous Welded Rails (*ENR*, Aug. 31, p. 278), the paragraph headed "Rolling-load test" contains several errors in the statements attributed to the report.

The paragraph states that "Two gas-fusion welds and two Thermit welds failed to stand *even one cycle*" (italics mine); also the statement is made: "Of three gas-heated pressure welds, two failed under less than one cycle." No welded joint tested failed under less than 59,500 cycles, and statements of the number of cycles before failure are meaningless unless the corresponding wheel load is stated.

The following is suggested as a correction for this paragraph in your abstract:

COMPARATIVE STRENGTH UNDER REPEATED WHEEL LOADS OF WELDED RAIL JOINTS AND RAIL WITHOUT WELD

Based on endurance limit (stress) for fracture after 2,000,000 cycles of wheel load.

Type of weld	Weight of rail, lb. per yd.	Approximate ratio of fatigue strength of welded rail to that of rail without weld
Electric pressure butt weld	131	More than 0.79*
Pressure butt weld with gas	112	0.73
Thermit weld	112	0.61
	131	0.66*
Fusion weld with gas, Process A	112	0.51
Fusion weld with gas, Process B	131	0.28*

* Rolling-load machine was not large enough to break 131-lb. rail specimens without weld, so that value is estimated from strength of 112-lb. rail. Electric butt pressure rail also proved too strong to be broken on rolling-load machine except at "stress-raisers" outside of weld.

With the exception of the paragraph noted, the abstract was an excellent one and I wish to thank you especially for calling attention to the foreword to the progress report.

H. F. MOORE
In Charge, Investigation of Continuous Welded Rail
Urbana, Ill.

The word "cycle" as used in our abstract referred to the cycle of 2,000,000 wheel loads set up by the committee as the limiting number of rolling loads representing a fair length of service life for a rail. In retrospect, it is evident that its use could result in confusion, as Prof. Moore states.—EDITORS.

Pavement Joints

Sir: I have read with much interest the article by W. S. Downs, *ENR*, Aug. 3, p. 154. In this article Prof. Downs states that joints should be spaced at 10 or 15-ft. intervals in concrete pavements.

I do not agree with Prof. Downs in regard to this spacing of joints. This state began the construction of concrete pavements on a large scale in 1921 and except in a very few instances no joints were placed in any of these pavements until about 1934. In checking over these pavements today we find that the average distance between transverse cracks is approximately 70 ft. and it should be kept in mind that this average distance between transverse cracks exists after the pavements have been down for an average period of time of eleven years and without transverse expansion or contraction joints. It is also believed that the present condition of these old pavements compares favorably with the condition of pavements in any other section of the country when considering the time that they have been in use.

While I heartily agree that transverse expansion and contraction joints should be placed, it is felt that in a climate such as exists in this state it is not necessary to place expansion joints at closer intervals than one every 100 ft. with one contraction joint between. Every time a joint is placed in a pavement it weakens it unless it is necessary to take care of expansion and contraction so as to prevent additional cracks from forming in the pavement.

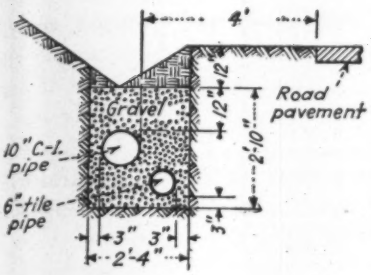
It is my observation, based on past experience with concrete pavements in North Carolina, that if a ¾-in. expansion joint is placed every 100 ft. and one contraction joint placed halfway between, there is very little transverse cracking of the pavement.

W. VANCE BAISE
State Highway Engineer
Raleigh, North Carolina

Pipelines in Ditches

Sir: The city of Helper, Utah, has its source of supply of culinary water in the mountains eighteen miles from the city. The original wood stave gravity pipeline tapping these springs was constructed in the year 1925.

The city now has a PWA project to replace this wood stave pipeline with cast-iron pipe. Since most of the distance traversed by the pipeline is in a canyon through which the state highway has occupied the most desirable location in which to place the line, it is quite necessary that the pipeline in its new location follow in the cut ditch of the highway for considerable distances. Some controversy has ensued in regard to the most desirable method of constructing this pipeline in the cut ditch. The state road commission has suggested a method of handling the construction of the line as shown by the accompanying diagram. It is my



contention that the theory prompting this type of construction is not correct. Since the soil is impervious, any leaks in the pipeline would naturally show on the surface in a very short time if the pipe were covered with the natural soil. The pipe could then be excavated and the leaky joint caulked. This would not allow the escaping water to soak up the roadbed.

By using gravel, as suggested by the state road commission, I feel that the water would be retained in the ground, not only allowing the roadbed to become soaked, but would make it nearly impossible to find any leaks in the pipe. Of course the theory is that the tile line, located as shown, would carry off the water so as not to damage the roadbed.

It would be very interesting to have the opinion of other engineers on this problem.

CARL NYMAN
Civil Engineer,
Price, Utah

Inadequate Foundations

Sir: In a news item on p. 180 of your issue of Aug. 10 there is a statement that Karl Terzaghi, in his report on the settlement of the 20-story Charity Hospital in New Orleans, states that there is not "the remotest possibility for the settlement to be due to inadequate bearing capacity of the piles."

There could be no settlement if piles were properly driven to refusal and proper depth, and the necessary number of piles were used. A building of this height should never have been designed in the rolling and shifting soils of New Orleans.

The writer has put in pile-foundations through sand, quicksand and muck fetching up on gravel for a 40-story building. The building is ten years old and there is no settlement whatever.

Mr. Terzaghi further states that settlement could have been avoided at a reasonable expense by excavating the cellars down to the depth of 60 ft. Just picture going down to a depth of 60 ft. in New Orleans silt and clay. What a mess to take care of: water, sheetpiling, shoring, bracing, pumping and excavating. The cost would be prohibitive.

The building department in New Orleans is lax to allow a building of such height. No building over ten stories should be allowed.

MAURICE BLUMENTHAL
Consulting Engineer
New York, N. Y.

Retrospect on Wind Design

Sir: The writer in an article, "Windbracing without Diagonals for Steel-Frame Office Buildings" (*Engineering News*, March 13, 1913, p. 492), making no claims to originality, presented methods that he called the Cantilever and the Portal, for determining wind stresses in tall buildings. Bulletin No. 80, dated June 1915, of the University of Illinois Engineering Experiment Station is a monograph of 88 pages by Professors W. M. Wilson and G. A. Maney entitled, "Wind Stresses in the Steel Frames of Office Buildings." This paper may be regarded as a classic, so often has it been quoted. The assumptions made in what they call "Fleming's Methods" are given near the beginning of the text, and in "Conclusions" the methods are condemned. Notwithstanding adverse criticism the methods, with more or less variation, have been used in the design of hundreds of skyscrapers.

During the years 1934 and 1935 a series of eight articles by W. Watters Pagon, a consulting engineer of Baltimore, was contributed to *Engineering News Record*. They were later brought together in a monograph, "Wind Design by Aerodynamic Principles." No attempt will be made to present a condensation, they should be read in their entirety. A significant sentence in the conclusion of the last article reads, "Possibly no engineer has yet made provision for *outward* pressure on walls and *upward* pressure on roofs, and made provision for torsion on the building as a whole." The subject of torsion in a structural frame is ably treated by Prof. George E. Large in the Sixth Progress Report of the committee on wind bracing of the American Society of Civil Engineers (*Proceedings*, Vol. 65, p. 969, June, 1939).

The literature on the determination of wind stresses is enormous. No common agreement has yet been reached on a method. The slope-deflection method of Wilson and Maney and some of the other methods that have been proposed are impracticable in actual design. The conventional methods do not require a preliminary design. Their weakness is that they assume the wind to follow a definite path, regardless of the stiffness of the members through which it must pass to reach the reaction base. The writer has at different times proposed that after wind stresses be obtained by one of the conventional methods, say the Portal, the frame be proportioned and then revised in accordance with one of the later methods.

D. S. Molitor in the chapter, "Wind Stresses in Building Frames," of his "Structural Engineering Problems" (1937), says, "it is futile to attempt a so-called accurate analysis of a tall building frame because, in practice, the result is no more trustworthy than that obtained by a simple, rational, approximate method." He gives such a method (a slight variation of the Portal method). In the same chapter he corrects a common erroneous opinion when he writes: "In the usual type of tier building construction, in which the frame consists of beams and columns without diagonals, wherein all wind shears must be resisted by bending, the inherent rigidity of the frame is due to the number of columns of given story heights, and not to the ratio of height to width of frame alone. Of course a wide building usually contains more columns than does a narrow building, nevertheless, it is the number of columns and the rigidity of the beam and column connections which determine the rigidity of the frame as a whole."

It is invariably conceded that in design the assumptions made for working stresses due to wind pressure may be greater than those from other loads.

Important as are the assumptions made for wind action in the design of a many-storied building, they are seldom left to the judgment of the designer. Usually they are determined by the building code of the city in which the building is located.

ROBINS FLEMING
New York, N. Y.

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SEPTEMBER 14, 1939

UNDER THE SHOCK of war involving half the civilized world disturbance of all normal pursuits is inevitable. In these circumstances it becomes the duty of everyone to look forward and find his part in the work of the immediate future. Engineering and construction cannot expect to remain unaffected, and while the future alone can tell what lies ahead the men of the industry must chart their courses now by the best data at hand. To assist in this task we present an objective view of the situation on the two pages immediately following these editorial pages.

New Work at Panama

A CONSTRUCTION JOB totaling $277,000,000 is in prospect in the construction of a third set of locks for the Panama Canal. A third set of locks directly alongside the present twin locks would cost only about two hundred million dollars, but as military strategists urged that the new locks be removed as far as practicable from the present locks the cost of channel excavation had to be added, since the new locks are needed to meet military rather than commercial requirements. Fortunately the work can be started as soon as Congress provides the money. Realizing that a third set of locks would be needed within the next 25 years, and recognizing that about ten years would be required for construction if the work was not done under pressure, the army engineers a few years ago asked for money to begin exploration work and design studies. These studies now are far enough along so that earthmoving can begin at any time.

Dam Supervision

AN ITEM OF SALVAGE from the New England flood disasters of the past three years is the establishment of state dam supervision in Connecticut by the last Legislature. The floods of 1936 and 1938 destroyed a number of old dams, mainly small and neglected ones, and aroused anxiety about others, to the point where both people and legislators concluded that better assurance of public safety should be provided. Control of the use of surface waters had previously been instituted by the state, and the present addition of control over the condition of dams is a proper supplement to that activity. Under good administration there is no reason for anticipating that such control will restrict competently directed industry or hydraulic enterprise, while it does erect a valuable safeguard against neglect or incompetence.

Spiral Curves Again

SHALL WE SPIRAL highway curves? The answer is a perennial subject of debate. About a year ago in these pages the editor took occasion to question the value of highway spirals. The response was as expected. Disputants from Maryland to Oregon and one even from England sprung to their typewriters to indite wordy defense of the spiral. Pages would have been necessary to print all the comment that was received, but a part was given (*ENR*, Sept 8, 1938). Now in this issue there comes a renewed protest from the veritable seat of tradition of the spiral curve. It deserves studious attention, and one strong reason why is that it disputes successfully all beliefs that the spiral curve is tedious to compute and to lay out.

Settling Up

MANY CONTRACTORS find to their sorrow that cleaning up the last debris and loading out their equipment does not mark the end of the job, for final settlement of accounts still is left. Usually some disputed payments and claims hang fire after work is finished. Often the contractor is faced with the tempting offer of immediate payment of his final estimate and retained percentage if he will sign a waiver to all claims and disputed amounts; otherwise he will have to wait. What is he to do? His financial situation may be such that he needs the moneys due him to meet obligations incurred on the job and to keep in business; yet he hates to waive his rights. George R. Shields, Washington attorney, in this issue gives the contractor some sound advice as to what to do, especially on federal contracts. He recommends where possible acceptance of the offered payment under protest to protect all rights to claims, or the signing of a qualified release to reserve rights to all claim items of merit. Even where absolute waivers have been signed, he cites encouraging

court decisions where the court found the waiver was signed under duress and the contractor's rights to claims were restored. Contractors will do well to study this article, for in these times they deserve all they make in construction.

Technique for Better Concrete

PROGRESSIVELY over the past ten years emphasis in the concrete-making field has been turning from high strength to greater durability. Greatest advance has been made in mass concrete for dams, where shrinkage effects from high heats of hydration produce cracks. Beginning with Boulder Dam, which influenced the development of a low-heat cement and introduced the use of cooling coils in the freshly poured concrete, each new project has advanced the practice of heat dissipation in one or another particular. In this way a technique of crack control has slowly developed. Hiwassee Dam, now being built by the TVA, probably goes farther in applying this technique than has any other project. In many respects it represents the first time that a complete technique, as distinct from a few special expedients, has been tried. Since some of the concrete is over a year old and since cracking has been eliminated even in the most vulnerable spots, the practice at Hiwassee deserves close study.

The Old Mill Pond

AT A MEETING of citizens discussing stream pollution a prominent sanitary engineer was addressed in this fashion: "Isn't it true, Mr. X, that a stream will purify itself in seven miles of travel?" Mr. X declined to answer on the ground that this depends on a number of factors. One of the factors he undoubtedly had in mind was the effect of storage. The importance of storage as an aid in stream purification is clearly set forth in an article on p. 91 of this issue. Here it is shown, among other things, that a stream receiving the benefits of short-term storage in a mill pond recovered its initial dissolved oxygen content in about one half mile of travel. But without storage it failed to recover even half this amount in 12 mi. of travel! Sunlight and air, of course, are the great natural agencies of stream purification. The ease with which these forces can be harnessed by simply providing a storage lake suggests that in our drive toward stream pollution abatement, restoration of the old mill ponds which once dotted the country might be considered as a helpful measure.

Again on Their Own

WHEN CONGRESS adjourned without providing new appropriations for PWA loans and grants it closed the books on a remarkable chapter in the history of public-works undertakings in this country. Last week John M. Carmody, federal works administrator, implemented the Congressional decision by returning 5,043 project applications to the sponsors, neatly marked "No Funds." Beginning now, therefore, states and cities are once more on their own so far as their local public works are concerned. Important adjustments will have to be made, forgotten responsibilities resumed, but when the transition is made everyone will be the better for it.

The resumption of normal public-works financing, which the return of the project applications foreshadows, was inevitable. For six years the federal government had given the local governments a 45 per cent discount on their public works bills. It was an unusual arrangement, justified by an emergency, which became untenable when the emergency had passed. And for most local governments today the emergency is over. Their credit is good once more. Interest rates are below any level in history. There is good prospect that extraordinary expenditures, as for unemployment relief, will go down rapidly. The transition to a normal economy, where local governments finance their own public works, should not entail much hardship.

It is stated that the estimated cost of the returned projects totaled nearly two billion dollars, and that sixty per cent of them had been passed upon favorably. It may be assumed that they represent needed, useful public facilities that should be built. Administrator Carmody says that they offer "a splendid opportunity for private enterprise and industry to show what it can do." Unfortunately he states only half the case, for before private enterprise can begin to function public opinion in the local communities must agree to pursue the projects without federal aid.

First responsibility, therefore, rests with the local public officials and engineers to secure this agreement. They know whether the buildings, the streets, the viaducts, the sewage treatment and water supply plants and the flood control projects are necessary. They know that the cut-rate cost under PWA was fictitious because federal taxes are paid from the same pocketbooks as are local taxes. And they know that city growth and well-being demands a continuous public-works improvement program.

Effect of the War on Construction

AN EDITORIAL ANALYSIS

WHOLLY NEW CONDITIONS confront every activity since Europe went to war. Neither trends nor plans are crystallized as yet, but there is quite natural speculation on what the future holds in store. How will war affect construction? What part will the construction industry be called on to play? To all in the industry these are the questions of the moment.

Different conclusions will be drawn depending upon assumptions. Best present opinion is that the war will be long, that the United States will be a neutral for as far into the future as one can safely venture a guess, and that the World War pattern of construction will be followed in this country, with some variations.

New conditions and forces—Three primary changes dominate the situation: (1) a huge increase in world consumption because of war wastes, (2) stoppage of production in half the world's workshops, and (3) interruption of long-established streams of commerce. Production and trade evidently face profound change, for the shortages created must be supplied by American industry. Its manufacturing facilities will soon be heavily taxed, its railroads, ports and other tools of commerce likewise.

Superposed on these influences is the powerful impulse given to the preparedness movement. The efforts of recent months to place our country in impregnable position are about to be intensified, in civil as well as military fields.

Rising prices are the first effect of these causes, aided by speculative stocking-up. Higher prices bear on construction, for high costs tend to discourage while improved farm income and industrial profits may stimulate construction.

Rising interest rates follow rising prices; they make construction capital cost more. Capital cost may not discourage industrial expansion, as this is controlled by business volume and profit expectations. State and municipal borrowings for construction may be slowed down eventually, but any threatened interest rate rise above current low levels would invite cities to finance their work before the rates go too high.

Increased production is certain to bring more employment and more purchasing power. Any drop in relief rolls and WPA activities would have a healthy influence on construction because it should stimulate construction of municipal public works to provide for essential needs.

The experiences of 1914 to 1917 taught volumes about war effects, but there are differences between then and now. In 1914 minds were unprepared for war, and panic set in that lasted for months; today there is no panic. Industry, commerce and finance are more resistant to shock, in spite of ten years of deep depression. Then, the United States owed money to Europe; today, Europe owes us money.

Nevertheless, like forces should produce like results. The high-pressure industrial activity that had to provide for war-made shortages during 1914-1916 will again be necessary. Rapid rise of prices and the attendant speculation and readjustment are likely to have the same effect as before.

Industrial plant requirements—Turning to existing conditions and the effect of war requirements on construction, industry's needs claim first place.

Heavy production demand is likely to strain the capacity of present manufacturing plant, operating now at some two-thirds to four-fifths of nominal capacity. By no means all of our plant is up to full efficiency or full capacity, and when subjected to pressure some of it will need rehabilitation or extension. Only part of the depression obsolescence has been made up. Some branches of industry and some individual concerns of progressive outlook and ample resources have modernized well, but our plant as a whole needs keying up.

Obsolescence led to a strong wave of plant improvement in 1915, which grew to great size before it was checked by the recession and slowed down almost to a stop. During the past spring and summer it has been gaining new momentum, and increased production demand appears sure to speed up this plant rehabilitation. In addition to modernization, new plant construction will be necessary if power becomes a decisive factor, for

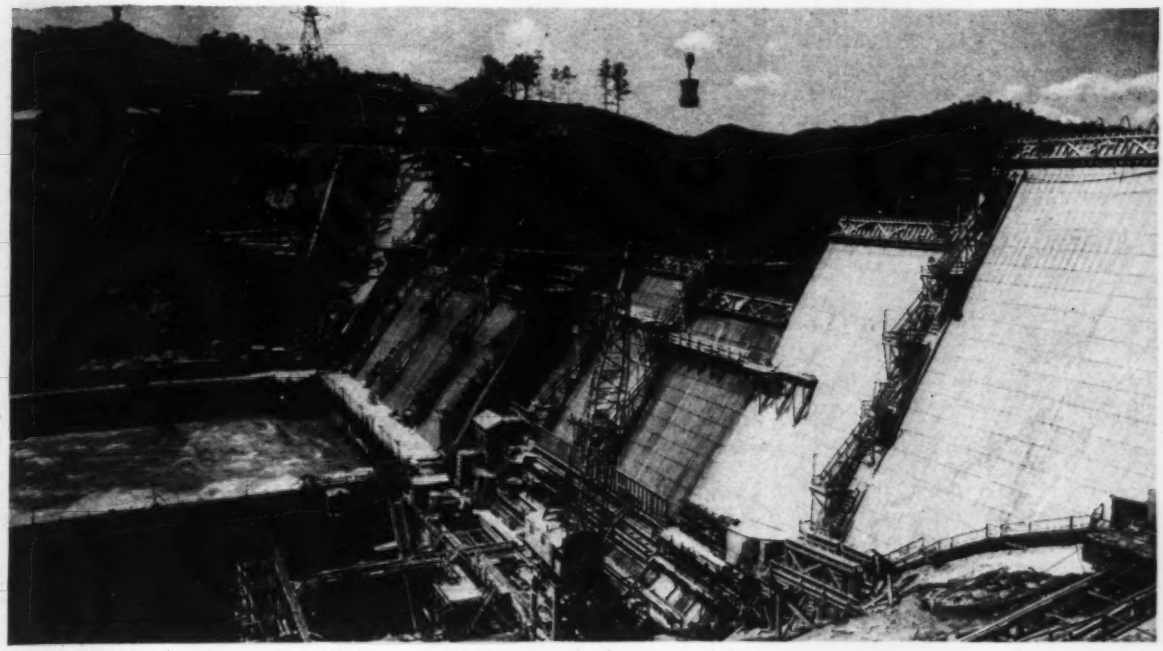

FIG. 1. MORE THAN HALF FINISHED, HIWASSEE DAM WILL BE READY TO GO INTO SERVICE NEXT AUGUST.

Crackless Concrete for Hiwassee Dam

***Contents in Brief**—New TVA dam, highest gravity overflow structure until Shasta and Grand Coulee are completed, will store floodwaters and generate power on one of the important Tennessee River tributaries above Chattanooga. All possible precautions—ten in all—are being taken to produce a concrete that will be free from cracks and therefore of maximum durability. These include use of low-heat cement, refrigerated mixing water and various construction expedients that tend to reduce the temperature rise of the setting concrete.*

HIWASSEE DAM in southwestern North Carolina is the sixth dam to be built by the Tennessee Valley Authority. Like Norris, but unlike the others, which are relatively low navigation, flood control, and power dams across the Tennessee River, Hiwassee is on a tributary and is a high dam. Its functions are flood control storage (total storage, 430,000 acre-ft.), power generation (one 60,000-kw. unit of the two provided for will be installed initially) and improvement of navigation on the lower Hiwassee and the Tennessee rivers. Located 60 mi. east of Chattanooga, Tenn., the dam will regulate the flow of Hiwassee River floodwaters into the Tennessee River and thus contribute substantially to a reduction of that city's flood danger, said to be greater than any in the country.

Slated for completion next year, Hiwassee Dam is now well up to schedule with nearly 600,000 of its 800,000 cu.yd. of concrete in place. A straight, gravity overflow structure 1,292 ft. long at the crest, it is 307.5 ft. high from lowest point in the foundation to the top of the dam in a vertical plane and thus will be the highest of its type in existence until the completion of Shasta and Grand Coulee dams in the West.

In appearance, Hiwassee Dam is similar to Norris Dam in that it is of the gravity type with a spillway near the center of its length and, in general, its design is not unusual. In the refinement of its construction methods, however, and particularly in the extreme attempts being made to eliminate or reduce cracks in the concrete, Hiwassee Dam is outstanding. Safety provisions for the construction workers, efficient wooden panel forms, graded crushed rock for sand and coarse aggregate and an extensive dust collection system for the aggregate plant to eliminate the silicosis hazard are other notable features of the work which will be described in a subsequent article.

Foundations are relatively simple. The base rock is known as graywacke, a metamorphosed sandstone that is very hard and uniform. It outcrops on the abutments and in the streambed, and the only construction difficulty was caused by the presence of several faults in the streambed parallel to the thread of the stream and connected by horizontal lenses of disintegrated rock from 3 to 24 in. thick. The foundation excavation, which extended to a depth of about 55 ft., was blasted and

removed in three stages of rock-crib cofferdam construction. In one place, where sound rock occurred on top of a disintegrated seam, 36-in. calyx drill shafts were sunk, and the decomposed rock in the seam was mined out by working from the shaft. The cavity and shaft later were filled with grout and concrete.

The general arrangement and dimensions of the dam are shown in Fig. 2. It is being built in blocks from 32 to 50 ft. wide. A grout curtain along the axis of the dam, put down with 2½-in. diameter holes 40 to 80 ft. deep on 5-ft. centers, is used to assure a watertight cutoff. The spillway discharge is controlled by seven radial gates along the crest, while four conduit outlets controlled by 102-in. ring seal gates are located in the spillway section near the base of the dam. Two 18-ft. penstock openings are provided immediately south of the spillway. The maximum combined discharge of the spillway and regulating conduits is 150,000 cfs.

Crack control

Ten different provisions are being made to eliminate cracks in Hiwassee Dam. None of them is novel but the combination of all on one job is believed to be unique. So far, after a year and a half, there are no cracks on either the up or downstream faces nor in the galleries, although a few cracks have appeared in the contraction joint faces between monoliths

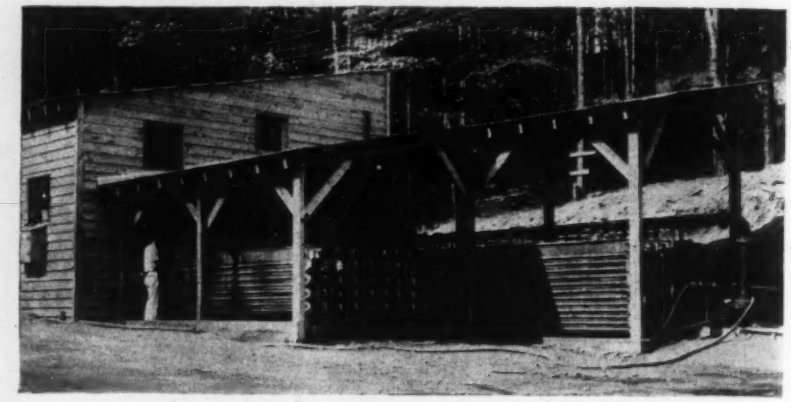

Fig. 3. Refrigerating plant for cooling mixing water consists of two 40-ton ice-making machines and necessary brine coils.

where high differentials existed and where the faces were exposed for a considerable time. The ten crack prevention measures are as follows:

(1) Use of low-heat cement. The low-heat cement used, was obtained under special specifications providing for limiting compound composition to the following maximum percentages: C_3S,35; C_2S,65; C_3A,7; and C_4AF,20. The specifications also required a fineness between 1,700 and 2,200 sq.cm. per gr. and stipulated the following minimum low early strengths: 500 lb. per sq.in. in three days 1,000 lb. in seven days and 2,000 lb. in twenty-eight days.

(2) Use of low cement content—0.8 bbl. per cu.yd. for mass concrete and 1.15 bbl. for up and downstream face concrete. The latter has an average thickness of about 8 ft. and is poured integrally with the mass concrete.

(3) Use of low lifts of pour—2½ ft. on all rock foundations and on concrete that is over 15 days old. Otherwise, 5-ft. lifts are used. On concrete 15 days old, two 2½-ft. lifts are used and on 30-day-old concrete four 2½-ft. lifts are used before a single 5-ft. lift is permitted.

(4) Long intervals between pours—a minimum time interval of exposure of one day for each foot, that is five days for a 5-ft. pour, which often means a week since work is shut down on Saturday and Sunday.

(5) Refrigeration of mixing water in summer to a temperature from 35 to 40 deg. from the normal river water temperature of 80 to 85 deg.

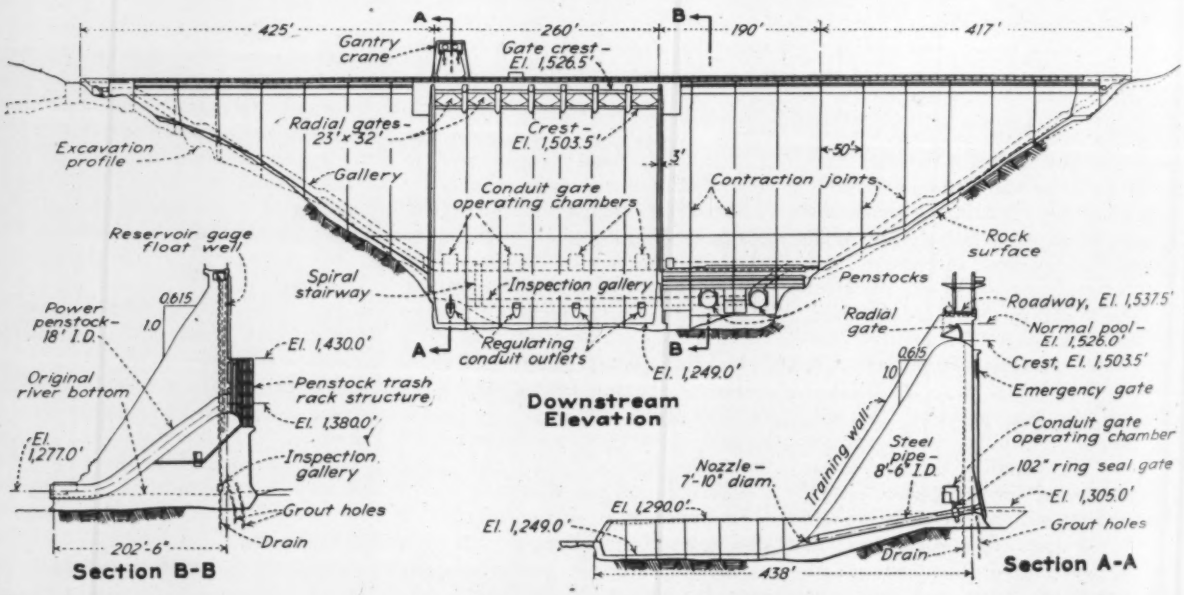

Fig. 2. Arrangement and general dimensions of Hiwassee Dam being built by TVA on a tributary of the Tennessee River.

Maximum concrete placing temperature usually obtained is from 70 to 74 deg.

(6) Carefully controlled heating of mixing water in winter by a steam plant, which results in a placing temperature of about 50 deg. except on rare occasions when a temperature of 45 deg. may be reached. During freezing weather green concrete is protected by heating the top of the blocks with steam coils and covering with canvas tarpaulins.

(7) Washing of aggregates by means of a rinsing screen in order to stabilize the proportions of various sizes of aggregate, then blowing compressed air through them in summer to standardize the moisture content and to lower their temperature about 3 deg.

(8) Use of diagonal keys in contraction joints in the lower third of the dam. Keys are placed parallel to downstream face (which is approximately along the line of principal load stress where the shear is low) with the anticipated result of keeping any tendency to form cracks away from this face. The top two-thirds of the dam contains no keys, as a compromise between two schools of thought. Steel reinforcement was used to prevent cracks from forming, especially around large gate recesses and galleries, and in special cases to prevent small cracks on the bulkhead walls from continuing upward.

(9) Careful clean-up of construction joints. First an air-and-water jet is applied from 8 to 12 hr. after each pour. Then, just before the next pour is made, the air-and-water jet is again used plus an additional feature of a sandblast on an area whose depth varies from 30 to 40 ft. from the upstream face.

(10) Curing of the concrete for three weeks by spraying water over the top of each pour and over both the upstream and downstream faces. In blocks with high differentials, or in blocks with large variations in the rock foundations, or when long exposures were necessary on account of emergencies, the concrete was artificially cooled by circulating river water through pipes. The temperature of the concrete was reduced about 10 deg. by this expedient.

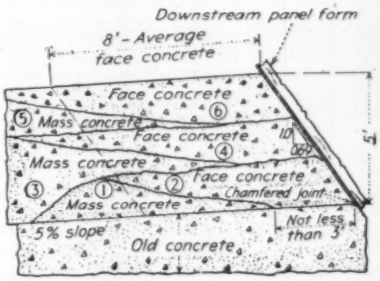

Fig. 5. Sequence of pours for keying downstream face concrete to mass concrete of body of dam.

A majority of these provisions have a common objective, namely to reduce the temperature rise and thus reduce shrinkage which causes cracking.

Another feature (related to crack control) is the elimination of ragged edges at horizontal construction joints by the use of a $1\frac{1}{4}$ x $3\frac{3}{4}$-in. chamfer on the dam faces at 5-ft. vertical intervals. Similar chamfer joints are used on the vertical contraction joints. Thus an unusual architectural appearance results since the dam face is marked off in panels 50 ft. wide and 5 ft. high. An exception occurs in the spillway which is left smooth in keeping with the vertically flowing water and because horizontal chamfers might produce cavitation.

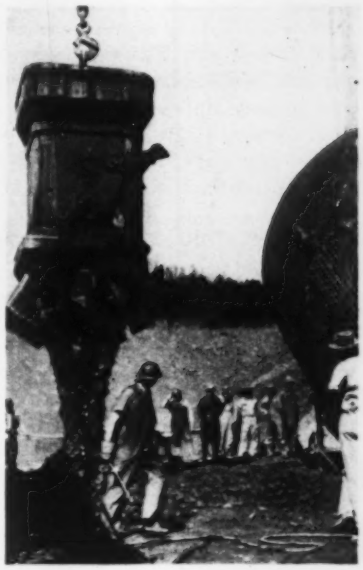

Fig. 6. Depositing concrete from $7\frac{1}{2}$-yd. cableway bucket. Maximum permissible drop of concrete is 15 ft.

Concrete manufacture

The concrete mix used is graded to approach a straight line on log paper from 6-in. maximum size down to minus 4-mesh. About 3 per cent of the total mix passes a 100-mesh screen. However, since some grinding occurs in mixing the final percentage of fines is more. At infrequent intervals a too-sandy mix occurs, which is attributed to this grinding action on a batch of aggregate that is somewhat softer than the average. Sand is sharp and mixes tend to be harsh. but despite these disadvantages very good results are being obtained.

The water-cement ratio for the mass concrete is set at 0.8 nominal, with a 0.78 ratio being used to take care of any accidental increase from water in the sand. By the same token, face concrete is made with a 0.6 nominal water-cement ratio while the actual ratio used is 0.58. A $2\frac{1}{2}$-yd. batch

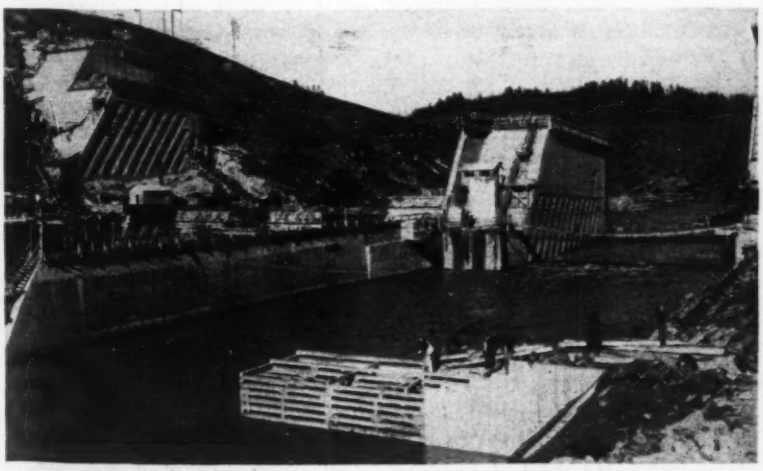

Fig. 4. Building the downstream crib of the last cofferdam. Note diagonal keys on faces of dam blocks to provide shear resistance in the contraction joints. Keys are not used in upper part of dam.

of mass concrete contains 23 per cent sand or 2,097 lb. of aggregate smaller than 4-mesh size. The remaining 77 per cent, or 7,021 lb., of coarse aggregate is made up of 2,462 lb. of 3 to 6-in. cobbles, 1,732 lb. of 1½ to 3-in. coarse aggregate, 1,550 lb. of ¾ to to 1½-in. medium size aggregate and 1,277 lb. of ⅜ to No. 4 fine rock. There are 752 lb. of cement and 602 lb. of water in a mix.

Three 3-cu. yd. mixers are being used, but each mixes only 2½ cu. yd. which fills the single 7½-cu. yd. bucket that is handled by the cableway. Hopper cars operated by gas-electric locomotives bring the concrete to the cableway from the mixing plant. Two hoppers on each car dump into a central chute which leads into the cableway bucket. Because of the harshness of the mix this chute is equipped with a small vibrator to assist the concrete to flow.

Several special requirements govern placing of the concrete. Specifications limit the height of the cableway bucket at discharge to a maximum of 15 ft. above the dam surface. All concrete is deposited on a rising slope of 5 per cent from upstream to downstream face. And finally the stronger face concrete is keyed to the interior mass concrete along a sawtooth line formed by overlapping the two types of concrete in successive lifts.

To study service behavior

Elaborate measuring instruments to study service behavior are being installed in the dam. Some $20,000 has been appropriated for this purpose. Of the five sets of instruments installed each set is made up of twelve strain meters and two stress meters. In addition, samples of the material placed around the instruments are being sent to Prof. Raymond E. Davis at the University of California, where a test program to duplicate field load and temperature effects will be undertaken in the laboratory. An additional $6,000 has been appropriated for this work.

Hiwassee Dam was designed and is being built by the Tennessee Valley Authority, under the general direction of Theodore B. Parker, chief engineer, and A. L. Pauls, chief construction engineer. At the dam C. E. Blee is project engineer, O. Laurgaard, construction engineer and J. E. Walters is the construction superintendent of this project.

Hog Feeding Dominates In Garbage Disposal

***Contents in Brief**—A recent survey by the U. S. Public Health Service shows that 52 per cent of 763 cities studied are feeding garbage to swine. Such practice is said to be chiefly responsible for the dissemination of trichinosis.*

MORE THAN HALF of 763 cities surveyed by the U. S. Public Health Service dispose of municipal garbage either in whole or in part by feeding it to swine. American municipalities are the largest feeders of raw garbage to swine and are therefore chiefly responsible for the dissemination of trichinosis, according to a report by Willard H. Wright, acting chief, division of zoology, U. S. P. H. S., presented recently before a conference of state and sanitary territorial health officers.

A total of 397, or 52 per cent, of the 763 cities studied employed hog feeding for disposal. Twenty-two cities maintained a municipal hog farm. Garbage from only 29 of the 397 cities was cooked before its consumption by swine but even in some of these cities only a portion was cooked. Reports from 231 cities gave a total of 302,296 hogs fed on municipal garbage and marketed in 1937. Details of the survey are shown in Table I.

The study was made in connection with a study of trichinosis, a disease caused by a worm transmitted to humans through consumption of insufficiently cooked meat containing the larvae of the worm. The disease in its initial stages is marked by intestinal disorders and later by severe muscular pain and stiffness.

One in every six persons in the United States is said to be infected with the parasite. Human trichinosis, said Mr. Wright, is based almost entirely on porcine trichinosis and the latter on the all too common practice of feeding uncooked garbage to swine. Consequently, the most rational procedure for the control of the disease involves the elimination of garbage feeding or the proper cooking of garbage prior to its consumption by swine.

The situation today, it was stated, plainly indicates that methods of garbage disposal have not kept pace with the marked improvement effected during recent years in other municipal sanitary services.

It was pointed out that geographical areas in which many hogs are raised on garbage are the areas having the most clinical trichinosis. There is even some further correlation between the percentage of cities feeding garbage to hogs and the trichinosis morbidity rate. For instance, Pacific Coast states, where 83 per cent of the cities dispose of garbage by hog feeding, have the highest morbidity rate of any section.

TABLE 1 — SURVEY OF GARBAGE DISPOSAL BY HOG-FEEDING IN CITIES OF 10,000 POPULATION AND OVER.

State	Total no. of cities	No. of replies received	Cities feeding garbage to hogs
Alabama	14	12	1
Arizona	2	2	2
Arkansas	9	5	4
California	47	41	38
Colorado	8	6	6
Connecticut	31	20	12
Delaware	1	1	0
Dist. of Columbia	1	1	0
Florida	14	12	4
Georgia	15	13	3
Idaho	2	2	2
Illinois	58	46	20
Indiana	34	28	20
Iowa	21	16	13
Kansas	20	14	14
Kentucky	12	11	4
Louisiana	8	6	2
Maine	11	9	8
Maryland	6	6	1
Massachusetts	73	56	53
Michigan	40	34	22
Minnesota	14	10	4
Mississippi	12	11	7
Missouri	16	14	10
Montana	6	5	1
Nebraska	8	6	3
Nevada	1	0	...
New Hampshire	10	8	5
New Jersey	55	44	7
New Mexico	3	2	2
New York	69	51	11
North Carolina	21	14	6
North Dakota	4	3	2
Ohio	59	51	29
Oklahoma	15	12	9
Oregon	6	5	4
Pennsylvania	92	66	13
Rhode Island	12	11	9
South Carolina	9	8	1
South Dakota	6	6	1
Tennessee	8	7	1
Texas	36	30	18
Utah	3	1	1
Vermont	4	4	4
Virginia	14	13	5
Washington	15	12	6
West Virginia	10	8	1
Wisconsin	27	19	8
Wyoming	2	1	0
Total	964	763	397

Rolled Fill Levees on the Rio Grande

Contents in Brief—Laboratory-controlled moisture content and field-supervised compaction by tamping rollers adopted for levee enlargement. Construction methods described.

SCIENTIFIC earth compaction is being employed in levee reconstruction on the flood-control project of the Lower Rio Grande in Texas. Thus for the first time, at least on the Rio Grande, consolidating thin layers of moistened fill by successive passes of a sheepsfoot roller and controlling the resulting density, moisture content and imperviousness by laboratory and field tests have been applied to a type of earth structure usually thrown up loosely by the cheapest methods known to the earthmoving fraternity. The net result of these dumped fill methods has been high cost of maintenance, many breaks and serious damage to contiguous areas by floods. Analysis, control of moisture content and compaction to produce a desired density, although costing an additional 2 to 4c. per cu.yd., has therefore been considered worth the price by the engineers of the International Boundary Commission in its program of strengthening and reconstructing levees along the North Floodway, 7 mi. north of Mercedes in Hidalgo County, Texas.

Before embarking on this project an investigation was made of the experience of the army engineers with the floodway levees in the Sacramento valley, which had been severely tested by the floods of the winter of 1938-39. More than 20 breaks occurred there in the floodway section and 60 in privately-owned levees above the flood-control works. Repairs cost nearly half a million dollars for the breaks and the additional washing, caving and sloughing. Six causes of the California breaks are noted as follows:

1. Inadequate maintenance due to lack of funds, the levees becoming infested with burrowing animals. Col. L. B. Chambers, district engineer, Sacramento District Office, U. S. Engineers, stressed the damage done by burrowing animals. Rodents, usually squirrels or gophers, are active in many localities and the damage done is usually not known until high water is against the levee. The holes allow the interior of the levees to become saturated quickly, resulting in many failures. The presence of these pests is not easily noticed and is encouraged by heavy growths of grass, weeds or brush often not removed either on the river-side or the land-slide slopes.

2. Insufficient patrols during floods to discover at an early date rodent holes and incipient breaks so that they might be repaired before they became serious.

3. Overtopping of levees not yet brought up to grade and section.

4. Cracks due to shrinkage and settlement of materials placed by draglines permitting the passage of flood waters. These cracks appeared between old levees and enlargement sections and were mostly longitudinal but in a few cases were transverse to the line of the levees.

5. Leakage along irrigation culvert pipes through the levees. Some pipes were not tight and the passage of the irrigation water carried away material surrounding the pipe, subsequently letting flood-water follow along the pipe barrel.

6. High velocities which carried away loose materials of the levee.

From these findings it was concluded that loose-fill levees of the kind of material available placed by large-capacity casting equipment could not be depended on unless otherwise compacted, especially where the levee had been reconstructed merely by the addition of new material. In consequence, Sacramento specifications for levees have been recently changed to include compaction of both the inspection trench and the levee during construction. These clauses do not apply to sand levees or clamshell fills constructed from wet material.

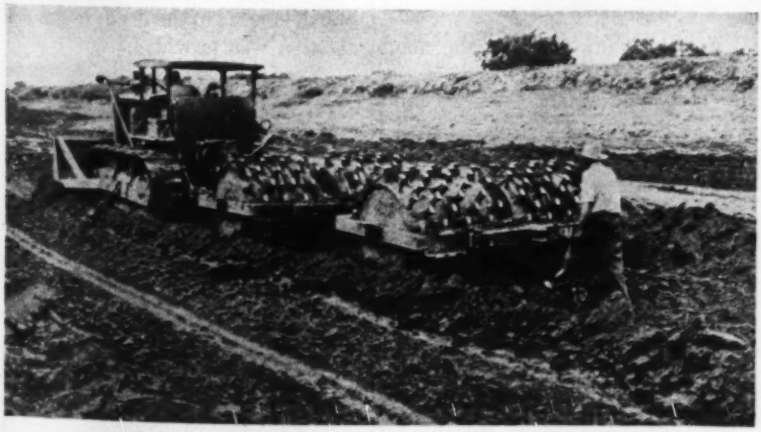

Fig. 1. A tractor pushing a bulldozer leveled the levee material to 8-in. depth and hauled two tamping rollers for compaction.

Fig. 2. Most of water was added at the borrowpit but 3½ gal. per yd. was sprinkled on in the fill to raise the moisture content 1 per cent.

While every condition is different, experience during floods in the Rio Grande valley has been somewhat similar to that in the Sacramento Floodway. Much of the original levee construction was through heavy soil thrown up by dragline from borrowpits on the water side of the levees. The settlement in many cases has not been incomplete, moisture from rains not penetrating much over 2 ft. and an arch of crust was often discovered over cavities which harbored rodents, owls and snakes. Advent of floodwater against such a structure permitted breaks. Consolidation methods by jetting some of these levees were described in *Engineering News-Record*, March 19, 1936, p. 407.

Fig. 4. Truck discharging material from pilot channel on spoil bank and 12-yd. scraper leveling levee waste bank.

Fig. 3. End of the contract which widened old "bicycle" top levee on the inside to a 16-ft. crown and filled in a 1 on 3 slope plus old water-filled borrowpits.

Following the extreme floods in 1932 due to cloudbursts on the Devil's River, which produced a flow of 200,000 cfs in the Rio Grande at Penitas, the International Boundary Commission settled on an allocation of floodway capacities on both sides of the river as shown in the detailed layout and table in the article previously noted. The North Floodway originally was designed to take 50,000 cfs but in the section north of Mercedes near the boundary of the two counties is a hump never fully excavated and only 16,000 cfs passed in the 1932 flood. Lowering the grade by a cut in the center of the floodway and strengthening levees in the section ahead of the hump therefore was undertaken. The lowering job involved is 1,800,000 cu.yd., with the excavated material deposited against the levees as reinforcement. As the quantity of cut was much in excess of fill requirements, consolidation was accomplished only by the equipment passing over it. In the section where the levee was strengthened, a 600,000-yd. project, material was borrowed from a central pilot cut and compacted by tamping rollers. The prices for the two kinds of work are respectively 10.5c. per cu.yd. and 12.7c. per cu.yd.

Construction methods

In the narrow place in the floodway the cross-section was increased by deepening rather than widening due to the high value of adjoining land and the location of a large distribution canal adjacent to the levees. The length is 14,400 ft. and the bottom of cut varies in width from 250 to 750 ft. and in depth from 1 to 10 ft. The material was hauled by tractor-drawn carryalls from 1,200 to 1,500 ft. to fill old inside borrowpits and to build up the levees. Loading was done by power shovels and by elevating graders at one point; at another, eight tractor-drawn 12-yd. carryall scrapers were used. The material was dumped in 18-in. layers.

The channel excavation included a drain ditch, 25 ft. wide, at a grade 1½ ft. below the bottom of the channel. This ditch provides drainage for the surrounding farm lands, connecting culvert structures of concrete pipe being laid to it under the levees.

The reinforced levee section is 13,100 ft. long and the material was taken from a central pilot channel 12,533 ft. long and 223 ft. wide with a cut from 1 to 9 ft. deep. A bottom ditch similar to the drain in the other section was provided.

Specifications for the compacted fill prohibited casting directly into the

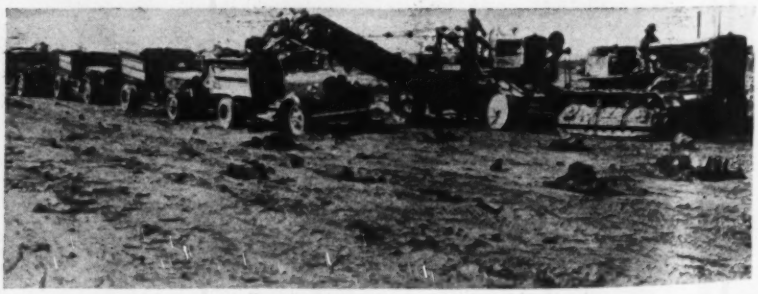

Fig. 5. Elevating grader in pilot channel loading 2-yd. trucks.

levee section with a shovel or dragline. The fill was built up in 8-in. compacted layers to an elevation giving 5 per cent allowance in height for possible shrinkage. The original levees had a 1 on 2 outside slope which was not disturbed. The crown is 16 ft. wide and the inside or waterside slope is 1 on 3 which permits equipment to traverse it in any direction. Also, this flat slope is expected to be easy to seed or sod, and once grassed will be kept down by grazing and mowing. On 1 on 2 slopes cattle graze infrequently but they will graze on 1 on 3 slopes.

The compacted material is a mixture of clay, sand and silt which was hauled in by trucks, spotted by an inspector, and dumped to give an 8-in. layer after the sheepsfoot roller has passed eight times. Water was applied by the border method of irrigating the borrow area and by sprinkler truck on the fill to give an optimum compacting moisture. An approximate determination of the density was accomplished by needle tests made at frequent intervals. For closer results samples were analyzed in the well-equipped laboratory of the commission in San Benito. Results indicate that the compaction produced a weight of 95 to 110 lb. per cu.ft., whereas the loosely dumped material in the old levees weighs but 55 to 60 lb. The undisturbed base on which the levee is built shows 90 to 95 lb., as does the borrowpit material in place.

Tamping rollers drawn by tractors did the compacting. On each 42-in. drum, 4 ft. long, were four rows of eleven tampers each. About 30 gal. of water ballast was used in each drum to produce a pressure of 210 lb. on each square inch of knob-bearing area. Payment for additional rolling was on the basis of 0.15c. per cu.yd. for each passage of the roller. Similarly a reduction was made for less than eight rollings.

Around structures, for 3 ft. laterally and for 4 ft. above culvert pipes passing through the levees, hand-operated air-driven tampers compacted the material to the same degree as is required in the balance of the embankment. Moisture was applied by a truck-mounted sprinkler of 935-gal. capacity. It required 3½ gal. per cu.yd. to raise the moisture 1 per cent.

Nine trucks with large bodies holding 4 yd. of loose material made twelve loads per hour with the distance from the channel cut to levee of 1,300 to 1,400 ft. Two power scrapers of 18- to 20-yd. loose capacity, giving but 11 cu.yd. of pay load, also were used on this job. Night work was lighted by portable gas-driven electric outfits.

The compaction job was handled by Chadwick & Williams and the excavation of the hump by H. B. Zachry Co. The work was done by the American Section of the International Boundary Commission, for which J. L. Lytel is project engineer, and V. R. Brady and W. W. Hall are associate engineers. L. M. Lawson is American commissioner of the International Boundary Commission.

Street Parking in Chicago

CURB PARKING on narrow streets constitutes a large factor in the traffic problem of Chicago, and provision for off-street parking, together with stricter enforcement of regulations, would be an important step towards the solution of the problem. This is the gist of a report to the public affairs committee of the Union League Club by W. F. Sloan, member of the subcommittee on transportation.

A traffic survey in 1938 showed 174,636 vehicles entering the central business area of Chicago in a typical day, 7 a.m. to 7 p.m. The problem is becoming acute because the number of automobiles is increasing faster than the population, the ratio now being 1 automobile to 6.4 persons, and it is expected to be 1 to 5 in a few years.

Intelligent regulation cannot be proposed without a comprehensive parking survey, the report states. Parking areas must be well located and of ample size, and the cost of parking must be low enough to stimulate the fullest use of the automobile.

Prohibition of curb parking during rush-hour periods can reduce street congestion, as it forces use of off-street storage by people who come to work in automobiles and now use a large part of the curb space for most of the day. It also clears the way for rapid movement of traffic during these periods. But people will not make general use of available off-street facilities as long as they are allowed to park on the streets. On the other hand, anti-parking regulation cannot be enforced unless adequate off-street space is provided at reasonable rates.

Space required for parking is estimated at 215 to 235 cars per acre for open lots, and 4 to 4.5 cars per 1,000 ft. square of floor space in inclosed garages. Cost of garage construction is $2.50 to $3.50 per sq.ft. of floor. This is exclusive of cost of land, which may be $20 to $200 per sq.ft. within the Loop district, or $10 upward for land adjacent to the Loop.

Suggested studies and recommendations of the report may be summarized as follows: (1) Make a complete parking survey of the city; (2) Study parking charges and costs to determine their effect on automobile traffic; (3) Prohibit left-hand turns to enter or leave parking lots or garages; (4) Enforce the present ordinance prohibiting double parking; (5) Write into the new building code a requirement that all new office buildings and large apartment houses must provide inside facilities for loading and unloading, and also require apartment houses to provide parking facilities in or near the building for at least 50 per cent of the tenants; (6) Designate certain streets leading out of the central business area as arterial highways, and prohibit parking on them during rush hours; (7) Investigate the advisability of establishing municipal parking areas, particularly in the business center; (8) Consider ultimate prohibition of parking on car-track streets in certain districts during rush hours; (9) Consider encouragement of the use of land for parking by means of some form of tax reduction; (10) Develop an extensive system of one-way streets in residential areas; (11) Study the possibilities of using air-rights over railways for parking.

Final Settlement of Government Contracts

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Contents in Brief—Court decisions bearing on the question of what is a final settlement under a government contract are analyzed to show what are the contractor's rights with respect to disputed claims. Pitfalls to be avoided are outlined.

WHAT IS A FINAL SETTLEMENT of a government contract is often a matter of rather vital concern to the contractor. The statute of limitations against suits (six years) arising under a contract begins to run from the date of such settlement, the date being the date of the contracting officer's certificate of the amount due. What, therefore, is a final settlement?

The answer is not as clear as might be desired. What is final in one case might or might not be final in another; but for present purposes, considering only government contracts with all their special statutory requirements, it is believed that a safe definition may fairly be advanced: A final settlement is that which is the exercised limit of authority of administrative officers to offer, certify or make. Beyond such settlement only the authority of the courts remains.

In governmental matters, however, a further complication arises. The contracting officer, who, under the contract terms, is generally named as arbiter of all disputed questions of fact, may well decide the facts, but have doubts as to the law of the matter involved, in which case, instead of paying the contractor in accordance with the findings of fact, he will submit to the Comptroller General the question of what, if anything, the contractor is entitled to receive. In such case, the Comptroller General's decision may or may not be the final settlement within the meaning of the law, depending on what the contracting officer has certified. Incidentally, in matters of the kind indicated, the contracting officer's findings of fact, not the Comptroller General's and not those of any one else, will generally be accepted by the courts as correct, the only deviation being where they are so manifestly in error as to import bad faith or fraud—a deviation rarely encountered.

Settlement on waiver

Of course it is always desirable to effect a good four-square final settlement where the respective rights of the parties are fairly recognized. Sometimes, but fortunately not often, it happens that the final settlement offered fails dismally to meet this test. Through prejudice, caprice or sometimes an innate inability to see both sides of a picture and hence to deal four-square, the contracting officer, or more generally his trusted representative acting for him, suspicious of possible pitfalls or mistakes and feeling it more his duty to save on construction costs than to insure a square deal to the contractor, may make decisions that completely ignore the real rights of the matter. And from such a situation arises the instances where a lawsuit, generally to be avoided if possible, is the last refuge of a contractor seeking only a square deal. This article aims to give an accurate idea on established precedents of what is to be done in such a situation. A great deal of grief and some financial loss may possibly be saved to those who regard with care what is here said.

It has sometimes happened of late that at the end of the work the contractor will be confronted with some such situation as this: There will be a substantial admitted balance due him, maybe as much as $100,000 or more (retained percentages, final estimates, etc.); there will be a number of disputed claims, some by the contractor and some against him, some of them reasonable and proper, others dependent on facts that are in dispute between the contractor's representatives and those acting for the owner, as well as others maybe of more or less unliquidated character, such as for damages alleged to have been caused by delays enforced by the owner to the disruption of the contractor's plans. In this situation it has sometimes happened that the contractor is bluntly told that the way to get what is admittedly due him is to waive all disputed items of claim, i.e., sign an unqualified release of all claims under the contract.

A somewhat more liberal attitude generally is taken. The representative of government sometimes has seen the justice of the contractor's claims and has offered to allow some of these, in addition to the admitted balance, but again conditioned on a full and final release of all other matters of claim. Some contracts specifically provide for the giving and acceptance of a qualified release; others, unfortunately, do not. Of course where the contract so provides, the contractor can at will except from the terms of the release any claims he considers valid.

Indicative court decisions

One example that has the benefit of final court decisions: The contractor had undertaken to do an expensive job of construction requiring a great deal of fabricated steel in its performance. He contracted for the necessary steel and had it delivered at the site of the work in a timely way. Due to change of plans the progress of the work was held up and the contractor was subjected to a very large expense in the way of storing the steel and taking care of it until such time as it could be used. Down at the end there was an admitted balance of quite large proportions due him, but he had pending with the contracting officer a claim for reimbursement of the extra costs incurred under the circumstances stated. The contracting officer gave

him a flat ultimatum of taking the admitted balance, signing a full release and calling the matter square, or getting nothing without suit. The contractor, under the situation which confronted him, took the money offered, gave the release, and then brought suit for the balance claimed on accounts stated, alleging that the release was exacted under duress. The court sustained his position and awarded damages for the delays occasioned as indicated.

What is one to do when offered an inadequate final settlement? The answer is doubtless what a very considerable number of present contractors with various agencies of the government would like to know. When one is being offered no more than what is concededly due as an earned balance under a valid contract with large items of claim, perhaps legitimate, denied, with the alternative of taking what is offered or going into an expensive lawsuit, what is one to do? This is a problem within the writer's personal observation that is arising not infrequently. It is one that is too often solved by the contractor's then financial situation, unreasonable and unjust as such a conclusion may be, and not by the intrinsic rights of the matter. If the contractor, as too often happens, is in a position where immediate cash is essential, when he cannot afford long to wait for the money admittedly due him, he generally goes, or is obliged to go, on the theory that a "lean bird in the hand" is better than a "fat bird in the bush", takes what is offered, signs the requested acquittance and forgets the matter, charging it off to experience.

There arise cases, of course, where even an urgent need for money cannot justify any such a sacrifice. Certainly no one should be obliged to take far less than what is due as an accord for disputed matters. The authorities are very well agreed, however, that unless there is legal duress involved in the transaction, one may legitimately agree to settle outstanding matters in the way of an accord and satisfaction on a basis that if carried into the courts might not stand the acid test of reason or justice.

A case arising some years ago should shed something of light on the rights of parties in a situation such as here described. There the plaintiff had a contract with the government to furnish it with his entire production of a certain product during a certain period. The product in question, being a wartime necessity, was of little value except for war purposes. After the armistice this contractor (with several hundred others in the same situation) was notified that a further supply of the product would not be required, and that he was accordingly to cease production. There were negotiations back and forth. Special preparations had been made for supplying the product and large stocks of the completed product were on hand and ready for delivery. Stocks of raw material were on hand or commitments made therefor for complete performance. In this situation the government notified him that unless he agreed to a modification of his existing contract, whereby the government would take, not what it had agreed, but a very limited supply after that date, the stock then on hand and ready for delivery would not be accepted and paid for, and he would be left to his remedy at law. The contractor (and others similarly situated) was in dire situation if the threat were carried through, and thereupon entered into a supplemental agreement, whereby the stock on hand was to be taken and paid for and a very limited quantity of the product thereafter accepted and paid for.

Suit was brought and carried through the courts on the ground that the supplemental agreement was made under duress and was not a voluntary act of the contractor. Judgment was eventually rendered in favor of the contractor, and most of the other contractors similarly situated have since collected their damages. The court concluded that the agreement was made under duress and constituted a breach of the original contract, on which the contractor was entitled to damages—that is, to what he lost by compliance with the supplemental agreement made only under duress. It should not be overlooked, however, that legal duress is a matter very difficult to establish in point of law. It must appear that failure to accept the offer tendered would result in irremediable loss and damage, and that the acceptance of the offer was based only on that idea and hence under duress.

Release not final

In another case that went to the Supreme Court the contractor had signed full and complete releases of all claims arising under the contracts there involved. The lower court held that these releases barred relief. On appeal to the Supreme Court it was held that it was a question of intent—whether the releases were intended to affect and relate to the then outstanding claims at the time the releases were signed—and on remand it was established that it was not the thought of the parties in signing the releases that the particular claims there asserted were in mind. That, however, is a situation that would hardly arise in any such case as we are here considering.

Another case is more in point. Under a ship repair contract, on a cost-plus basis, the contractors were to be reimbursed on approved vouchers within thirty days from their submission. Approval of the vouchers was so delayed that a balance of nearly $1,000,000 had accrued in the contractors' favor, and other ap-

RECOMMENDED ACTION ON FINAL SETTLEMENT

1. When a contractor is being offered no more than is concededly due and at the same time is being denied the allowance of claims that are legitimately due, he should not sign an unqualified release at the end of the work as a condition to getting the admitted balance, but should accept final settlement under protest and with a clear reservation of his right to further prosecute and present claims that are justly due.

2. If, under duress, he is obliged to sign such a release, he should endeavor to get a record in writing so that the arbitrary purport of the action will be apparent.

3. If permitted to sign a qualified release, he should reserve his rights as to all items of claim that have a show of merit.

4. In either case, it might be prudent to act only under competent legal advice.

Again summarizing: Extreme care should be the watchword of all those coming to the end of the trail on a big job. Don't give away any rights, and let no rights die from non-assertion.

proved vouchers in large amount were outstanding. The contractors became in dire need of money to carry on. In the situation, payment of the approved vouchers was offered with the condition that a full and complete release of all claims under the contract be given.

The contractors, as obliged to do to avoid possible bankruptcy, signed the release, but later brought suit for balances justly due, and recovered a large judgment. The court said:

> Settlements and payments exacted by officials of the government without lawful authority and in arbitrary fashion, to which the parties have yielded sometimes under and sometimes without protest to escape onerous penalties and financial disaster, have been set aside innumerable times by the Supreme Court.

Parties may undoubtedly effect a full and final settlement notwithstanding outstanding matters in dispute if they all are in free agreement in that effort. There should be some valid consideration for any such release. Where a contractor is being offered nothing more than is concededly and certainly due him, that is, a mere balance of the earned contract price, his acceptance of that balance should, it would seem, scarcely constitute a valid consideration for releasing claims on other accounts.

High Speed Water Purification Plant

W. W. DeBerard

Associate Editor, Engineering News-Record

Contents in Brief—Two years' operation of the water-softening and purification plant at Springfield, Ill., indicates the feasibility of high-rate treatment using cloudtype precipitators and filters.

THE "SHELF-HARDWARE" type of water purification is not exemplified at the two-year-old Lakeside plant of the Springfield, Ill., waterworks. Enough time has elapsed so that all of the novel features have been tuned up and appraised. A recent inspection of the plant with Charles H. Spaulding, who was responsible for many of the features, indicated that his ideas were practically all workable. Starting at the point of chemical application the writer followed the water through the various processes including the novel upward flow precipitators, sludge-handling devices and filters after having first toured the reservoir lake shore recreation and housing development.

Water comes from Lake Springfield, the largest multi-purpose artificial lake in Illinois. In addition to water supply, this 22-billion gallon reservoir serves as a recreation feature, the land surrounding the lake being let on 60-yr. leases to numerous city people who have built substantial homes in the various restricted subdivisions controlled by the city. Streets and service improvements were installed by the city prior to initiation of leasing. Sewers lead out of the watershed.

At one point is an artificial sand beach and a bathhouse. The beach is the only source of pollution but has been so effectively treated as practically to eliminate any danger. The swimming area is inclosed by a permeable sheetpile dike. A low-lift circulating pump taking suction outside the dike discharges into a perforated pipe laid in a gravel-filled trench near the shoreline of the beach. In the summer season 80 lb. of chlorine per day is applied to this circulated water to prevent infection. This beach is two miles across the lake from the waterworks intake and no pollution has been traced to the beach nor has local objection to it been raised. Boating and yachting have been encouraged as an attraction to prospective home builders. The city, just four miles away, considers the lake one of its greatest recreation assets.

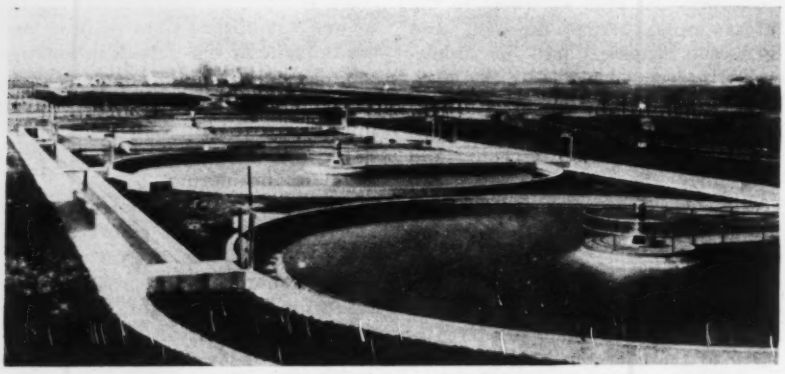


Fig. 1. Precipitators are in the shape of steel inverted funnels set in "dishpans", from which sludge is removed continuously.

Treatment

Returning to the purification plant, Mr. Spaulding started to explain that lime-and-iron solutions were being applied simultaneously but he felt that if the lime preceded the iron by a few minutes a bit better result might be attained. When alum is used the order is reversed. Alum is the principal coagulant used.

The circular precipitators were devised by Spaulding and are the greatest novelty in the plant. He describes them as inverted funnels set in "dishpans" 22 ft. deep. Water enters at the top center, is circulated by a vertical shaft paddle and rises through an annular space up through a sludge cloud, radial diaphragms curtailing the whirling action of the water as soon as it emerges from under the funnel. The water is skimmed off by

Fig. 2. Samples from inlet (right) and outlet of sludge concentration tank, showing quick settling of inlet sludge as it comes from the precipitator.

a circular weir. The designed rate of 6 mgd on the basis of a 2-in. vertical rise at the surface can be tripled without appreciable ill effect and has been conservative for low temperatures while in the summer double this rate gives equally good results.

Sludge is withdrawn continuously to a basin for further concentration from 2 per cent down to 10 per cent, and on occasion down to 30 per cent. The samples (see Fig. 2) held by Paul Rieser, filter operator, were taken a few minutes previous to the time the picture was taken and are from the inlet and outlet of the sludge concentration tank, showing rapid settling of the influent. The effluent is too thick to show much settling. Two sludge beds of one acre each are provided. The surface of one is shown in Fig. 3 after rain has melted a portion of the hummocks into the cracks. Farmers haul away the dried sludge for the lime content. They spread it to obtain about 200 lb. per acre of effective liming.

A switchboard in the chemical room shows pH in and out of the precipitators, various chemical feeds, elevation gages and electric switches for the low-lift pumps.

The four filters are unorthodox in that the sand has an effective size of 1 mm. rather than the usual 0.35 to 0.50 mm. No wash troughs are in evidence and the washwater must travel 13½ ft. maximum to the washwater gullet. Loss of head is not the criterion for washing, which ordinarily is done at regular 48-hr. intervals. In the washing routine the water is drained a few inches below the sand surface then for 2 to 3 min. a spray from a nozzle under 100-lb. pressure is played on the surface to break up the *schmutzdecke*. Washwater rise is 45 in. per min. and is applied only 3 to 4 min. when the water is clear enough for the sand to be seen. Due to the large size of sand its rise is limited and in consequence the tanks are filled to within 8 in. of the overflow weir edge. The high position of the sand is one reason for the elimination of the wash troughs. Further, the troughs would be in the way of the spraying operator.

The capacity of the filters runs high due to large sand and thorough preparation of the treated water. Three of the four units, having a normal rating of 3 mgd based on 4 gal. per sq. ft. per min., have handled 16 mgd or 67 per cent in excess of their rating. A 200-mgd per acre rate (5 gal. per sq. ft. per min.) is considered entirely safe and productive of zero turbidity and high bacterial removal. In 1938–39 the city tap samples averaged only 0.04 coliform bacteria per 100 mililiters, a reduction from 27 in the lake supply. Hardness is reduced from 168 ppm down to 84 ppm. Costs of softening and purification averaged $13.73 per mg sold in 1938.

The Springfield water purification plant is operated as a part of the City, Water, Light and Power Department under the direction of Willis J. Spaulding, commissioner of public property.

Fig. 3. Surface of sludge in the drying bed. Cracking and subsequent rain has melted hummocks into the cracks.

Water Softening for U. S. Lock Stations

Zeolite treatment for softening and removal of excessive iron content has been adopted for the existing water supplies to the residences and control stations at six locks on the upper Mississippi River. The water is from deep wells (except filtered river water in one case), with motor-driven pumps discharging into a 2,500-gal. tank to maintain a working pressure of 80 to 100 lb. The equipment in each case will include softener and brine tanks, zeolite regenerating apparatus (using common salt only), and necessary pipe and fittings. It is required to treat 5,000 gal. weekly, with not more than two regenerations per week, and the production of softened water must be a continuous flow of 22 gpm. This effluent is to contain not more than 6 ppm of total hardness by weight of calcium, and not more than 0.2 ppm by weight of iron, when tested according to the recommendations of the American Public Health Ass'n.

Complete regeneration must be made in 45 minutes. Zeolite is to be of the carbonaceous type, capable of removing 8,000 grains of hardness per cubic foot. The typical well water contains 12 ppm of iron and has a hardness of 24, with distinct earthy odor. Its scale-forming impurities are 3.28 lb. of solids per 1,000 gal., with 0.25 lb. soluble salts. No bacteriological treatment is necessary, since tests show a low agar count and B. coli analyses were negative. These plants will be installed under the direction of Captain A. G. Matthews, Corps of Engineers, U. S. A., acting district engineer at the U. S. Engineer Office, Rock Island, Ill.

Backwater Protection for Guntersville

Contents in Brief — Raising the level of the Tennessee River behind Guntersville Dam made it necessary for the TVA to build dikes to protect low-lying areas in the town of Guntersville and required the reconstruction of the town's sewer and water systems. Both were modernized and enlarged to care for anticipated growth of the town.

REARRANGEMENTS to protect private and municipal property and facilities at the city of Guntersville, Ala., due to the backwater of the reservoir above the nearly completed Guntersville Dam of the Tennessee Valley Authority on the Tennessee River involved an expenditure of about $1,000,000. While the city has but 5,000 population, it is the focus of several main trunk highways with a recently completed bridge over the Tennessee River carrying a heavy local, tourist, and truck traffic. It is the car ferry terminal of the Nashville, Chattanooga, and St. Louis Ry., which barges trains 22 mi. downstream to a similar terminal at Hobbs Island. Other interests requiring protection included a textile mill, an ice plant, cotton gin, basket factory, railway station and yards, the city's water supply and sewer system, a sawmill, and a certain amount of business and residential property. The raising of the pool leaves the town occupying the east side of the northern end of a peninsula 1¼ mi. wide and 3 mi. long with a high ridge running down the full length of the middle of this tongue of land.

The 94-ft. Guntersville Dam is to insure year-round 9-ft. navigation in the 82-mi. stretch from the upper end of the pool of Wheeler Dam to Hales Bar Dam, also to provide 271,000 acre-ft. of storage for flood control between El. 591 and 595.44, and to make available 33,000 to 44,000 kw. of continuous power. The drainage area at the dam site is 24,430 sq. mi. from which a maximum recorded flow in 1867 was 455,000 cfs producing a flood height to El. 590.8 at the dam site. Spillway maximum design capacity is 625,000 cfs.

The pool at El. 595.44 at the town of Guntersville, 9 river miles above the dam, covers the wide flood plains of the creeks above and below the peninsula extending back from the thread of the original river 6 to 7 mi. As the railroad, the industries, and some of the residences had encroached on the flood plain east of the city below pool level, it was considered most feasible and economical to build an 18-ft. levee outside of the railroad tracks and fill in low places up to pool level. Thus there was a minimum of house moving and property damage. Diking of the wide flood plain of Brown's Creek to the northwest of the city was not considered feasible, and land purchases were made instead of trying to salvage the area for agriculture. The railroad and highways were on embankments but were raised 10 to 15 ft. with a certain amount of relocation. A dock and new ferry terminal alongside the city were built and approaches graded to provide a 9-ft. navigable depth to deep water. Incidentally, a 5-acre park and shore improvement at the north entrance to the city were developed from harbor dredging materials.

A new river intake and filtration plant were substituted for the old inundated spring supply in Big Spring Creek flood plain. A new high-level intercepting sewer for do-

Fig. 1. The present town of Guntersville, Ala., as protected from backwater spread over the adjoining flood plains by the TVA dam 10 mi. below. The fill in the foreground carries the new river road and the N. C. & St. L. Ry. tracks. At the left end of the fill is the sewage pumping station and back of it is the stormwater collecting basin. At the right is the tank farm of the Gulf Refining Co.

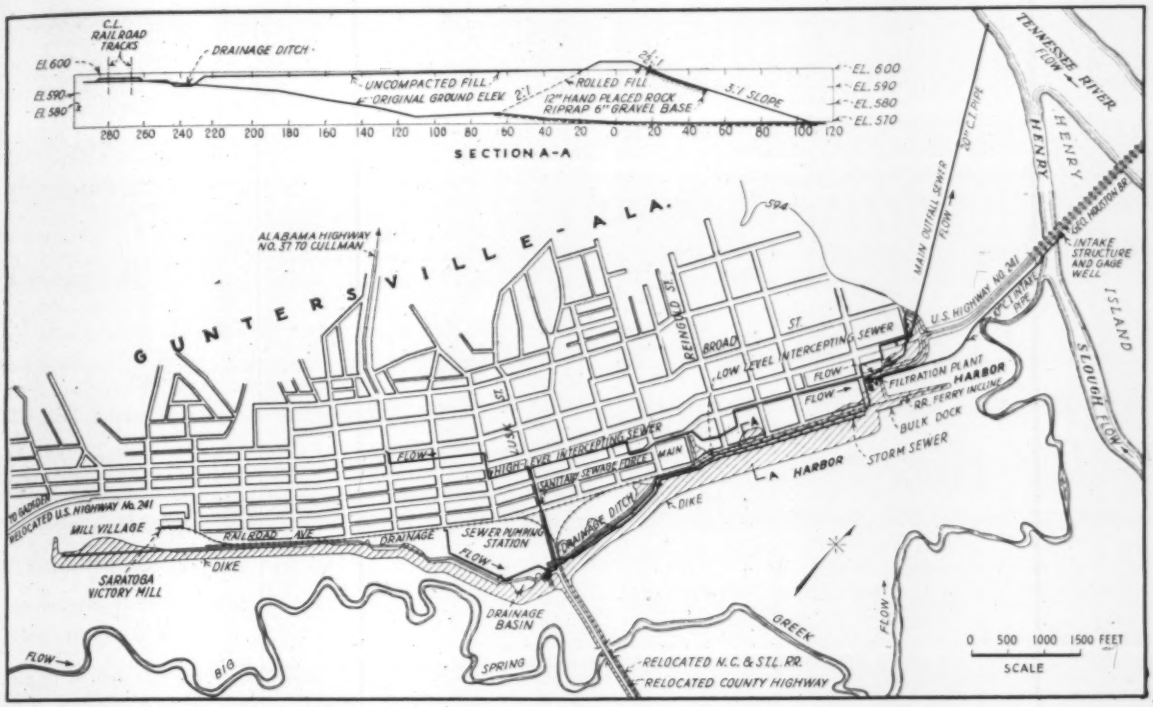


Fig. 2. Rearrangement of the utilities at Guntersville, Ala., made necessary by the construction of a dike to protect the town.

mestic sewage into which low-level domestic sewers now discharge from an automatic sewage pumping station was led the length of the peninsula and out across the river flood plain diagonally downstream some 4,500 ft. to an outfall into the main channel of the river 3,000 ft. below the George Houston Bridge. A stormwater sewer paralleling the dike discharges into a collecting basin at the Lusk St. station from which it is pumped over the levee into the Big Spring Creek pool.

Levees

The rolled-fill dike protecting the utilized land to the east of the main occupied area of the peninsula is 2½ mi. long and averages 20 ft. high. The top is at El. 604, 7 ft. (after deducting 3 ft. for backwater effect) above the highest flood stage of record and 10 ft. above normal pool level. It has a top width of 18 ft., 2 to 1 inside slope, 2½ to 1 and 3 to 1 water side slopes. It is riprapped 5 ft. above and below average pool level with 12 in. of hand-placed stone on a 6-in. gravel base. The dike was rolled with sheepsfoot rollers. The fill inside the dike is uncompacted; it extends only from the harbor to the stormwater collecting basin at Lusk St. For 3,000 ft. south of the harbor the fill is 280 ft. wide between the railroad and dike, providing waterfront space for industrial sites and warehouses. This location of the dike prevented pushing the railroad into town. A county highway was relocated to occupy, with the existing railroad from the east, a riprapped rolled-fill embankment crossing the flood plain of Big Spring Creek. A similar entrance was provided for State Highway 31 across Brown's Creek to the west. To the north across the river flood plain an embankment was extended from the end of the peninsula about one mile to Henry Slough where it joined with the long approach of the George Houston Bridge, which had been raised 17 ft. by the TVA highway division last year.

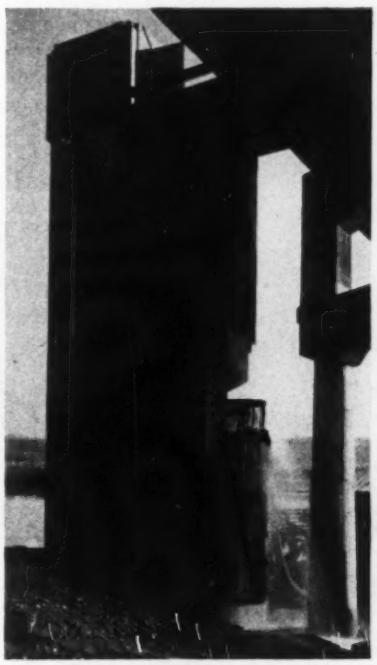


Fig. 3. Waterworks intake built alongside the highway bridge before the pool level had been raised.

Sewage pumping station

The combined sewage and stormwater pumping station located at the foot of Lusk St. is automatically controlled by floats in the collecting basin for stormwater and in a wet well for domestic sewage. The collecting basin has a capacity of 36 acre-ft. below El. 583, sufficient to care for a run-off of 3.5 in. per day from the tributary area. Two 20,000-gpm centrifugal units with 100-hp motors and one 10,000-gpm unit with 60-hp motor lift the storm drainage 16 to 20 ft. over the dike via one 24-in. and two 30-in. spiral welded pipes. Three 500-gpm units with 15-hp motors boost the domestic sewage for a distance of 1,500 ft. up the hill with a head of 41 ft. to the high-level intercepter. The floats operating the domestic sewage pumps

are set at three elevations putting them in operation in sequence as the sewage quantity rises.

Waterworks

The former water system consisted of a large spring in the Big Spring Creek bottom, a pumping plant and low-level steel tank, all of which would be completely submerged when the pool was raised. Gaging of the flow of several other springs demonstrated that for a supply capable of expansion to meet ultimate needs a filtered river water was the only source of supply.

An intake was located on the upstream side of the Tennessee River bridge with gravity flow 3,000 ft. through a 10-in. cast-iron pipe to a pump well in the new 650,000-gpd filtration plant which is located at the inner end of the harbor. Water is lifted from the wet well to a 3-pan aerator, going thence to mixing chambers, coagulation settling basins and two 11 x 11-ft. filters. Two 224-gpm high-service pumps operating under 245-ft. head lift the filtered water from a 70,000-gal. clear-water basin to the distribution system. Average daily use is 225,000 gal. The plant is run only during the daytime, being shut down automatically. Washing is done about every 5 days (a loss of head of 9 ft. being taken as an indicator) as turbidity is comparatively low (40 ppm when the plant was inspected by an ENR representative). Lime, alum, and chlorine are chemicals used.

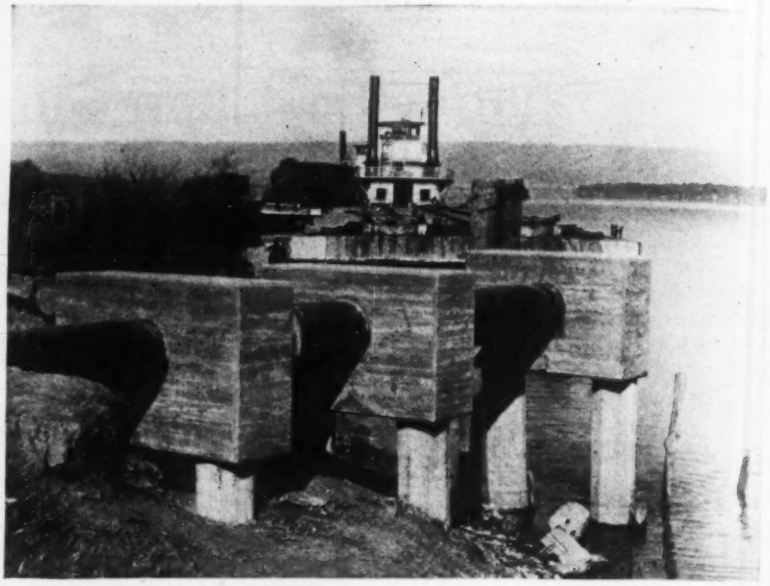


Fig. 5. Outfall of the high-level sanitary sewer interceptor 3,000 ft. downstream from waterworks intake at the bridge.

The harbor, boat dock, and land acquired by the TVA may be leased for a limited number of years. The filter plant and storm pumping station become the property of the town of Guntersville, but an annual payment for a limited number of years will be made by the TVA for maintenance and operation.

Other changes

A relocation, important from the point of cost and engineering interest, was the crossing of Brown's Creek west of the town by a 44-kw transmission line of the Alabama Power Co. Islands of rolled earth with riprapped slopes were constructed. Steel towers were then erected on heavy concrete footings. The work was done by the power company and paid for by the TVA at an agreed price covered by contract.

Sensing the possible advantages accruing to the town via the newly acquired facilities, including the improved highways, good bridge crossing, important railroad interchange between rail and water, possibility of increased volume of river traffic, one of the principal oil companies has constructed a "farm" of tanks just opposite the town on the far side of Big Spring Creek.

The rearrangements necessitated for backwater protection in the Guntersville pool are being carried out by the TVA under the general direction of T. B. Parker, chief engineer, and A. L. Pauls, chief construction engineer. Verne Gongwer is project engineer of the Guntersville Project, and Ellis H. Morgan was assistant construction engineer in charge of Guntersville backwater project. The state furnished a city planning expert who worked with Earl Draper, in charge of land planning and housing for the TVA on the city plan problems. L. H. Clouser, of the project planning division of the authority, was in charge of plans for backwater protection. Glenn Norrell is city water superintendent for the town of Guntersville and is now operating the filter and sewage pumping plants.

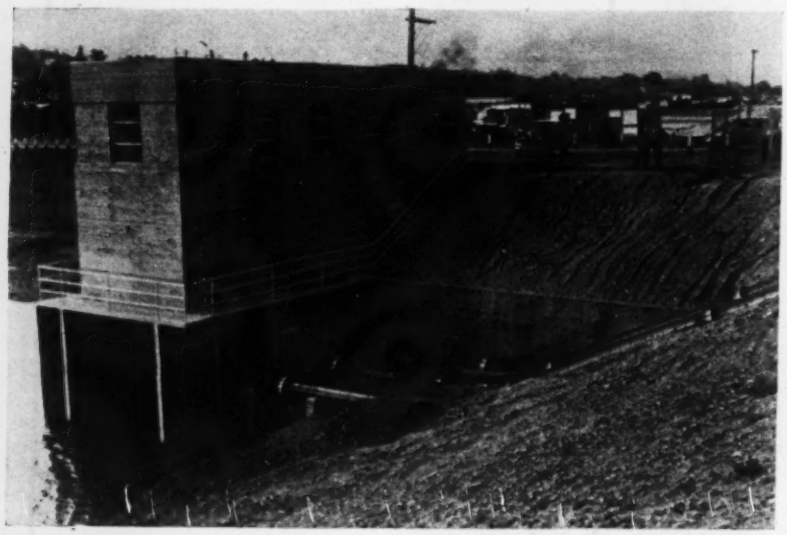


Fig. 4. Sewage pumping station in a corner of the collecting basin for stormwater. The three pipes carry stormwater over the dike.

Upside-Down Sedimentation Clarifies Centrifuge Effluent

Contents in Brief — A novel method of clarification involving the flotation of sludge has been developed as an adjunct to the centrifugal sludge dewatering process. By this means it is possible to produce a final effluent containing less than ½ per cent of solids.

A NOVEL METHOD of clarifying the effluent from a centrifugal sludge dewatering machine by means of quiescent flotation has been developed at the demonstrating plant of the American Centrifugal Corp. in Elizabeth, N. J. Centrifuge effluent containing as much as 3 per cent solids content is clarified by a upside-down sendimentation process to produce a final effluent containing less than ½ per cent solids, according to data furnished by the corporation engineers. The process is entirely mechanical and requires no chemicals. The process was demonstrated before a group of sanitary engineers and made public for the first time on Aug. 30.

Clarification is effected in the following manner: Effluent from the centrifuge is conducted to a clarifier tank and permitted to remain quiescent for 24 hr.; the inlet to the tank is at the bottom. During the period of quiescence the solids rise and form a mat of floating sludge averaging 7 to 8 per cent in solids content. The clarified liquid which is at the bottom of the tank and which is said to contain less than ½ per cent solids, is drawn off at the end of 24 hr.

The tank, still containing the layer of previously floated sludge, is again filled from the bottom with centrifuge effluent. After another quiet period of 24 hr. the second layer of solids is floated upward and rests against the bottom of the first layer. Once more the clarified liquid at the bottom is withdrawn, and the tank filled with centrifuge effluent. This latter filling is so controlled that the topmost layer of floated sludge is carried up beyond the rim of the tank where it can be easily skimmed off for final disposal. This layer of sludge, which has been floating for about 48 hr. and may have a thickness of 3 to 5 in., has a solids content ranging from 10 to 15 per cent.

A continuous process

Once the cycle has been established in producing a 48-hr.-old sludge layer at the top, the clarification process becomes a continuous operation. That is to say, the top sludge layer is skimmed off every day following sub-decantation of the bottom liquid and refilling of the tank with centrifuge effluent. The

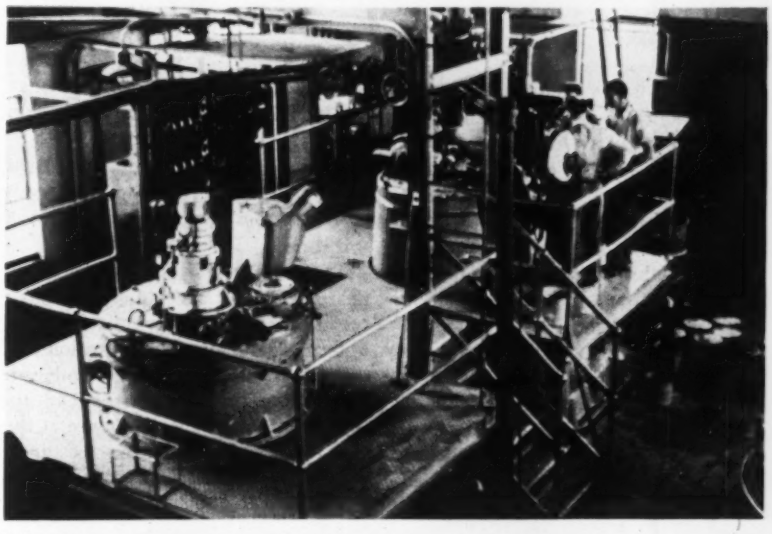


Fig. 2. Centrifugal sludge dewatering machines in the demonstrating plant where the clarification experiments were conducted.

Centrifuge influent	Centrifuge effluent fed to clarifiers		Clarifier				Detention period hrs.	Efficiency or % solids removal		
			Liquor sub-decanted		Solids removed					
% Solids	% Solids	Quantity	% Solids	Quantity	% Solids	Quantity		Centrifuge	Clarifier	Overall
6.04	3.06	666 gal.								
5.64	2.75	295 "	0.57	252 gal.			24	51.2	79.3	89.9
5.8	2.52	289 "	0.42	261 "			24	56.6	83.4	92.8
4.84	1.74	326½ "	0.41	294 "	11.3	52½ gal.	72 24	64.0	76.4	91.5
5.2	2.04	395½ "	0.35	323 "	9.84	31½ "	24	60.7	82.8	93.3
6.25	3.12	370½ "	0.36	316 "	11.2	52½ "	24	40.5	90.3	94.2
6.55	3.04	351 "	0.4	274 "	10.5	70 "	24	54.6	86.8	93.9
6.18	3.16	331 "	+0.62	259 "	10.5	84 "	24	49.0	80.4	90.0
6.3	3.13	259 "	0.45	259 "	10.2	59½ "	24	51.3	85.6	92.9
				259 "		66½ "	24			

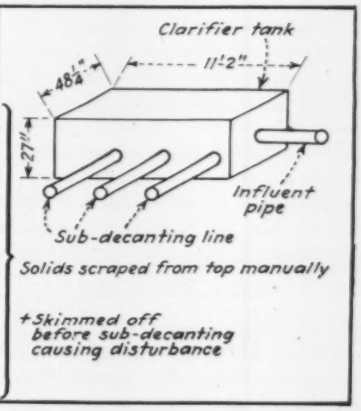


Fig. 1. Analytical data of clarification results obtained on the effluent from a centrifugal sludge dewatering machine.

solids content of the bottom liquid is said to be always below ½ of 1 per cent, and thus the effluent can be returned to the incoming sewage without detriment to subsequent treatment operations.

In partial explanation of the reason for the flotation of the solids, George E. Henkel, chief engineer of the American Centrifugal Corp., stated that the centrifuge effluent is high in grease content and, in addition, is filled with tiny air bubbles caused by the centrifugal spinning. The combination of grease and air cause the particles of solid matter to rise to the surface and stay there. It was also pointed out that the work to date has been confined to raw sludge, and that no results are available on the application of this clarification process to digested or activated sludge.

A summary of analytical data is shown in Fig. 1. These results were obtained on raw sludge from the primary sedimentation plant at Elizabeth, N. J., operated by the Joint Meeting of Essex and Union Counties.

The Bugbear of Spirals

C. C. WILEY
Professor of Civil Engineering, University of Illinois

Contents in Brief—Analyzes the effect of the spiral on the behavior of the vehicle or the process of steering; simple method of computing spirals outlined.

WHEN WE CONSIDER the bad traffic conditions that exist at the entrances to many highway curves and review the accidents and deaths that have occurred at such locations it is a distinct indictment of the profession that it has not long ago analyzed the problem and sought a remedy for the difficulties. Instead of this we have gone blithely ahead building conventional curves, content to place the blame for the accidents on the dangerous practice of the drivers. Actually the real culprit is the engineer, with the driver a sort of accessory after the fact.

Vehicle action on curves

No motor vehicle can change instantly from rectilinear to curvilinear movement. A finite interval of time is required to turn the steering wheel, during which the vehicle moves forward, and the natural action of the driver is to turn the wheel gradually at a rate that is convenient and gives smooth riding. If we assume that the wheel is turned at a uniform rate while the car moves at a constant speed, we can at once write the equation

$$\delta = \int ks\, ds = \tfrac{1}{2}ks^2$$

where δ is the total angular change of direction in the distance s and k is the unit increase in the angular rate of change of direction.

This equation is identical with the equation for the total angular change of direction of the common transition spiral (Pickels and Wiley, *Route Surveying*, p. 96, Eq. 31) and shows that the natural process of steering tends to cause the vehicle to move in a spiral path.

There is also another important factor having a similar effect, which seems to have been entirely overlooked. This is the superelevation and the manner in which it is introduced. To analyze this, consider a car approaching an unspiraled curve at the speed for which the curve is superelevated and that the runoff is placed entirely on the tangent, as is common practice.

On normal tangent the pavement is level transversely, hence the only lateral forces acting on the car are those incident to normal tangent driving. These are met by the ordinary process of steering. But, as the car traverses the runoff, it is subjected to an increasing lateral force due to the increasing tilt of the pavement. Since the alignment is straight this force is unbalanced by any centrifugal force. This force is considerable, being equal to 20 lb. per ton for each per cent of cross-slope. For a superelevation of 0.10 ft. per ft. it amounts to 200 lb. per ton or about four times that required to drive the car at 50 mph on an average road surface.

If the driver desires to stay in his proper lane he must overcome this force by steering against it. This steering movement is opposite in direction to that required by the curve, hence is not a natural movement and few drivers attempt it. This unbalanced tilt force is resisted only by a small component of the road resistance which may be neglected, consequently a lateral acceleration is developed which causes a lateral inward drift of the car.

Since the car is traveling at a constant speed and the tilt is increasing at a constant rate it requires only the application of the elementary laws of mechanics to derive the general equation:

$$y = \int \frac{nx^2}{2mv^2}\, dx = \frac{nx^3}{6mv^2}$$

where y is the lateral drift in feet, x is the distance traveled in feet, n is the unit increase in the tilt, m is the unit of mass, and v is the speed in feet per second.

This is the equation of a cubic parabola and it is well known that the common transition spiral is based on the cubic parabola. Hence it is demonstrated that an unspiraled curve with the runoff on the tangent also tends to cause the car to follow a spiral path.

If a spiral of the same length as the runoff is introduced the increasing lateral force due to tilt is balanced by an equal centrifugal force due to the increasing curvature. The effect of the unbalanced tilt is thus eliminated and the driver is relieved from any necessity of trying to compensate for it while the spiral alignment conforms to his natural steering

movement, as previously demonstrated. The introduction of the spiral actually simplifies the steering instead of complicating it as some seem to fear and at the same time eliminates the tendency for side drift and thus makes the road safer. The use of the spiral simply means that the road is built on the path which the car naturally follows under the forces acting on it and in accordance with normal driving procedure.

If a spiraled curve is approached at a speed above that for which it is superelevated part of the tilt will not be balanced by centrifugal force and there will be some tendency for the car to drift inward. This can be met by turning the wheel somewhat less than required by the curvature. On the other hand, if the approach speed is above the superelevation speed part of the centrifugal force will not be balanced by tilt and the car will have some tendency to drift outward. This can be prevented by turning the wheel slightly more than required by the curvature. In either case the wheel is turned in the direction of the curvature and with the entire length of the spiral in which to make the movement the steering is simple and natural. Thus the spiral simplifies the steering and makes the curve safer whether the speed is above, below, or at the speed for which it is superelevated.

Spirals are not complicated

In view of both the theory and the facts there can be no real question but that spirals on highways are highly desirable as contributing to easier and safer driving. Why, then, is there so much hesitance in employing them? Apparently the answer is an ingrained fear of the spiral which few will make the effort to overcome. The reason for this fear lies in the fact that almost all writers have so bungled the treatment of the spiral as actually to cause its application to be cumbersome and inexact, and to overcome this trouble, have begged the question by providing bulky and complicated tables. When properly treated, the spiral becomes quite simple as well as exact and no tables other than the trigonometric functions are needed.

If two tangents are to be connected by a circle the procedure is to determine a suitable rate of curvature and then use a length of arc that will fit between the tangents. In contrast, most writers on spirals have followed the reversed procedure of choosing an arbitrary length and then trying to make the curvature fit. This normally results in odd values, complicating the computations and the field work. But if the curvature characteristics of the spiral are selected, and then a spiral arc of proper length to fit between the tangent and circle is used, such bugbears as tedious calculations, trial-and-error adjustment and field delays entirely disappear.

But suppose they did not, what of it? Do such things singly or in combination form a valid reason for continuing to build hazards into our roads? The entire cost of spiraling all the highway curves to be built in the entire country during the next year would be far less than the cost of one major highway accident or fatality. If such a condition existed in the structural field we would make calculations by the acre and books and papers would be full of theories, formulas and diagrams. But since it is just the little old routine matter of highway alignment, and "anything is good enough on a road" we dodge the issue and blame the driver for not compensating for our own faults. "Consistency, thou art a jewel."

The first writer to present the spiral in a logical form was Prof. A. N. Talbot in his little book, "The Railway Transition Spiral," published about forty years ago. This method has been enlarged and extended to highway curves in "Route Surveying" by Pickels and Wiley.

In *Engineering News-Record* of Sept. 8, 1938, Mr. Barnett derives an equation for the length of spiral. This equation is practically identical with the one derived by Professor Moyer in Bulletin 120 of the Iowa Engineering Experiment Station. But Professor Moyer distinctly indicates that this gives the *minimum* length of spiral and not the normal length, as Mr. Barnett seems to infer. A study of existing curves and driving behavior indicates that normal spirals should be some 50 to 60 per cent longer than given by this equation.

But, as has been intimated, the spiral is more easily approached from the standpoint of its curvature than its length. It is, therefore, desirable to transform the length into curvature. Taking the basic equation of the spiral as $D = kS$ where D is the degree of curve, k is the rate of change of the degree of curve per station, and S is the length in stations, and changing D to R and S to L, in feet, we may easily obtain from Moyer's equation and the equation for superelevation, with sufficient accuracy, the relation

$$k = \frac{360{,}000}{V^3}$$

when V is the speed in miles per hour.

But this equation gives the *maximum* value of k (minimum length) hence the equation should be modified to give a normally suitable value. The writer therefore recommends the equation

$$k = \frac{230{,}000}{V^3}$$

for the normal highway spiral.

This equation should be used only to obtain an approximate or trial value of k from which a simple, convenient value is adopted. The exact length of spiral is then determined from the equation $D = kS$ following which the computations and field notes are made as indicated in the two books referred to.

When the profession once realizes how simple this procedure is the last vestige of an excuse for omitting spirals will have disappeared and we may expect our highway curves to be better looking, better riding and far safer to negotiate.

• • •

Much Fireproof Wood At New York World's Fair

More than two million feet of fireproofed wood has been used in the buildings at the New York World's Fair, according to recent estimate. The special building code prepared by the New York World's Fair requires the use of non-combustible materials in all buildings over 75 ft. high or in lieu thereof the installation of sprinklers. Fireproofed wood which has passed the New York City tests is acceptable as non-combustible. Requirements at the World's Fair are divided between permanent and temporary construction. In the former, the New York building code controls, while the World's Fair code applies to the temporary buildings and bridges.

The large quantities of timber scaffolding required in the interior of the buildings during the construction stage were all fireproofed at the suggestion of the city fire department.

Ingenious Cantilever Foundation

JULIUS LASKER
Engineer, Boston, Mass.

THE EXTENSION of the L-Street steam-electric plant of the Boston Edison Co., now nearing completion, presented the problem of supporting two new columns adjacent to an existing stack without imposing additional loads on the stack foundation. These columns designated on the accompanying plan as 2d and 2e, were calculated to carry about 750 and 1,050 tons respectively. Their position was determined by considerations of efficient plant layout. Some of the other columns, too, particularly 3d, 4d, 3e and 4e, are so heavily loaded (they carry 1,300 to 1,650 tons each) that individual footings for them would have overlapped.

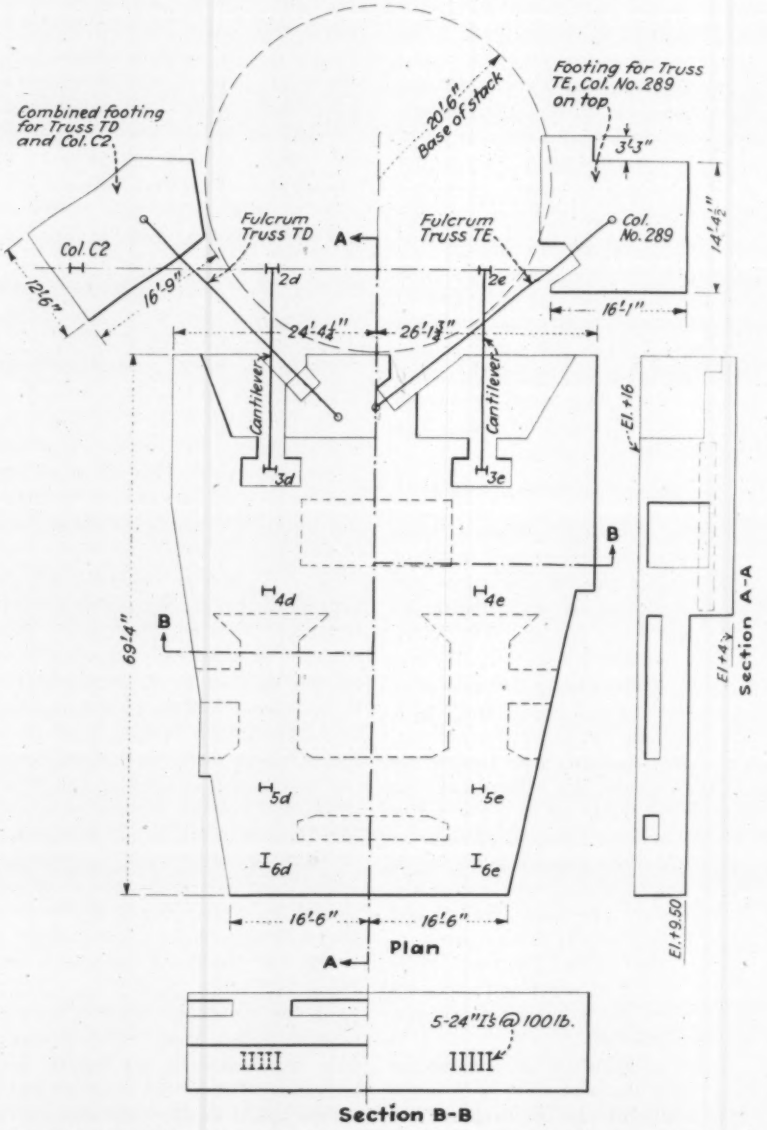
An attempt was made to design a common foundation, a continuous mat, for the six columns which was to clear the base of the stack, but the resultant of the loads came so far from the centroid of the mat that the soil pressure at the stack end would have greatly exceeded the allowable maximum of 4 tons per sq. ft. It became evident, therefore, that for a feasible design it would be necessary completely to eliminate the loads of columns 2d and 2e from the mat and to extend it further from the stack to include columns 5d, 5e, 6d and 6e to obviate eccentric loading. A cantilever arrangement suggested itself as the only solution.

The design adopted consists of two fulcrum trusses, running diagonally, each carrying a cantilever girder. Each girder is of 23¾ ft. long. The anchor arms frame into columns 3d or 3e, the loads of which are considerably heavier than the uplifts. To avoid interference with foundations of existing columns and the stack, the two trusses do not run at the same angle with the axis of the building and are also of different lengths. This made the cantilever arms of the two girders unequal, but since the shorter arm carries the heavier load, the two girders are of the same section.

The shears in each girder were so heavy that they could not be developed adequately even with the closest possible rivet pitch in the webs or cover plates of conventional girders. Each cantilever was, therefore, made up of two T halves of 36-in. 300-lb. sections connected by web plates on either side of the stems to give a total depth of 6 ft. To increase the section still further, additional flange angles were riveted to the webs, but not to the flanges. At points of concentrated loads, fillers were wedged between and welded to the flange angles and the T's so as to give adequate bearing for stiffener angles. The cantilever beams are supported on the bottom chords of the trusses, passing beneath the top chords.

The resulting uplift on the anchor arms of the cantilever girders considerably reduced the proportion of the load from columns 3d and 3e taken by the mat, thus decreasing the required size of the mat and bringing the resultant of the vertical loads closer to its centroid.

The only area in the crowded site which could be used as a foundation



Cantilever foundation designed to straddle existing chimney footing and relieve it of any building load.

for the end of fulcrum truss TE was already carrying a column which had to remain. It was, therefore, necessary to shore this column on a temporary steel frame and to demolish the foundation and replace it by a much larger one, adequate to carry the truss end. On the top of the truss a support was provided for the shortened column.

The design was developed in the office of Jackson and Moreland, consulting and designing engineers for the project, by the writer in the structural division, of which O. G. Julian is chief. The steel was erected by the general contractor, Thomas O'Connor, under the direct supervision of the engineers.

River-Gage Correction Formula

FRED W. RODOLF
Assistant Engineer, U. S. Engineer Office, Portland, Ore.

IN CONNECTION with work on the upper Columbia River, above tidewater, it became necessary to transfer a difference of —0.5 ft. on the U. S. Weather Bureau gage at Umatilla, Ore., to several other gages on the river so that soundings could be corrected to refer to a new low-water plane occurring on the river between Feb. 2 and Feb. 16, 1932. The gages to be corrected were at points on the river where the width of the river, slope of the mean low-water profile and bottom conditions varied widely from the section of the river at the Umatilla gage. As the information available was insufficient to handle the problem by ordinary methods, an attempt was made to derive a usable formula for the information at hand; namely, the width of the river scaled from old maps, and the mean low-water profile of the river corresponding to the higher reading on the Umatilla gage. This formula was worked out by the writer as follows:

The difference of —0.5 ft. on the Umatilla gage was considered as a depth of 0.5 ft. of water flowing in a canal with the surface width of the river at that point. As this water would be flowing on top of other flowing water and this condition would exist at the places where gages were to be corrected, the friction factor would be the same in all cases and could be disregarded, for on a river 1,000 ft. or more in width the shore friction of such a canal would be negligible.

As the gage correction was such a small percentage of the total depth of the river, the discharge being about 45,000 cfs at the time of the new low water, it seemed reasonable to presume that the gage corrections would have some direct relation with the slope of the low-water profile and the width of the river at the gage to be corrected.

If we let d = gage correction
s = slope of old low water profile at gage to be corrected
w = width of river at the gage
V = velocity of flow
A = area of channel being considered ($w \times d$)
r = hydraulic radius of channel
Q = discharge in cfs
$K = \frac{1.486}{n}$ (Manning's C)

Manning's formula for velocity of flowing water becomes

$V = K \times r^{2/3} \times s^{1/2}$, and as
$A = w \times d$, then $Q = V \times A$ becomes
$Q = K \times r^{2/3} \times s^{1/2} \times w \times d$,

and on a wide and shallow channel such as is being considered $r = d$, and then

$$Q = K \times d^{5/3} \times s^{1/2} \times w \qquad (1)$$

At Umatilla gage $d = 0.5$ ft., $s = 0.0001755$ and w scaled 1,980 ft., hence from the above formula we compute $Q = 8.3\,K$. This Q will be the same at all gages and represents the actual change in the total discharge of the river which caused the drop of 0.5 ft. on the Umatilla gage. As formula (1) is true for any gage on the river, it can be set up for a gage to be corrected, and, substituting for Q its equivalent $8.3K$ we get

$$8.3K = K \times d^{5/3} \times s^{1/2} \times w.$$

Since the friction factor n in K is the same in all cases, K can be canceled out; then solving for d, the gage correction to be applied, we get

$$d = \left(\frac{8.3}{s^{1/2} \times w}\right)^{3/5} \qquad (2)$$

the w being scaled from the map and s taken from the low-water profile at the point where the gage is being corrected. In scaling the width an average width for a reasonable distance above and below the point should be used.

As a check on formula (2) the d for the Weather Bureau gage at The Dalles, Ore., 100 mi. downstream, where w scaled as 1,500 ft., and s on the old low-water profile is found to be 0.000045, was computed thus,

$$d = \left(\frac{8.3}{(0.000045)^{1/2} \times 1{,}500}\right)^{3/5} = 0.89 \text{ ft.}$$

The Weather Bureau office at Portland stated that according to their records the —0.5 ft. difference on the Umatilla gage at that stage of the river would make a difference of 0.85 ft. on The Dalles gage. At the head of the Celilo canal 78 mi. below Umatilla, where a gage is read hourly to the nearest 0.1 ft. by the U. S. Engineers, the computed d checked the observed d by 0.03 ft.

Additional checks are to be desired on this formula, of course, but for gage corrections involving small percentages of the flow of a stream it seems to offer a quick and fairly accurate method for determining such gage corrections.

• • •

Power Output of TVA Dam To Be Increased

The electric generating capacity of the Wheeler Dam, TVA project on the Tennessee River in North Alabama, is to be doubled to bring the maximum generating capacity to 129,500 kw.

A contract to supply two 32,400-kw. generators at a cost of about $1,000,000 has been awarded the General Electric Co., Schenectady, N. Y. A contract to supply two 45,000 hp. fixed-blade propeller-type turbines for units 3 and 4 of the dam's power plant has been awarded the Baldwin-Southwark Corp., subsidiary of Baldwin Locomotive Works, Philadelphia, at a bid of $785,000.

Maintenance Experience on 120 Bridges

Contents in Brief *— In operating and maintaining bridges of wood, steel and concrete, Seattle has learned how to avoid dangers and where to look for economies. Present methods interpret and apply long experience.*

SEATTLE'S TOPOGRAPHY is such that bridges always will be an important item in the city's growth and development; similarly, the operating and maintenance requirements of bridges is an important item in everyday municipal housekeeping. With 120 bridges of more than 40-ft. span, some old, some new, of all types and sizes, it has been worthwhile to work out a complete operating system, now managed by Reed R. Hubbard as bridge maintenance engineer. The following information was obtained from him by a representative of *Engineering News-Record*.

The bridge record system is simple. Essentially it includes (1) a bridge index map showing the location and number of each bridge and (2) a vertical file in which are separate folders for each kind of record on each bridge. For example, on the general map of the city the University double-leaf bascule bridge is labeled No. 3. In the letter file, the folder marked 3-A refers to accident reports on this bridge; 3-B gives its maintenance record; 3-C contains the monthly report sheets used for movable bridges, recording the number of times the movable span was operated, average time open, power consumed in operation (as indicated by meter reading), etc.

In addition to municipally owned bridges the bridge maintenance department exercises supervision over about a dozen privately owned bridges which are used to some extent by the public. Regular inspections are made on all bridges in addition to the records compiled by tenders continually on duty on the movable structures.

Movable bridges

Movable bridges important enough to keep operators on duty 24 hr. a day require the employment of 4 1/6 men per bridge to provide three 8-hr. shifts and the necessary reliefs. One of these operators is designated leading bridge tender and is responsible for compiling monthly reports. The city has seven movable bridges in the three-shift class.

On some bascule bridges the center lock has been eaten away by electrolysis despite the presence of a negative return circuit. Return current from electric railway motors must get back across the canal to the power house and as high as 300 amp. has been found at times in the bridge center lock. Evidences of this electrolytic action have also appeared in the steel reinforcing in the piers, though not to a dangerous extent.

In operation of the movable spans, street traffic at rush hours has the right-of-way over small marine craft. Any boat of over 300 gross tons in the Lake Washington Ship Canal and 250 gross tons in the Duwamish waterway however, has right-of-way at any hour.

Accidents

A blank form is provided bridge tenders for recording data relative to traffic and boat accidents that occur on bridges where an attendant is stationed. An average of 28 bridge traffic gates per year were broken by automobiles in Seattle until careful analyses of traffic conditions developed additional safeguards to give both visible and audible warnings. Three kinds of warning are now used: (1) a plainly marked stripe on the pavement indicates the safe limit for traffic when the gates are coming down; (2) when the gates start down green lights change to flashing red and simultaneously (3) loud gongs ring. With these additional safeguards the list of broken gates in 1938 was reduced to 15: in the first 5 months of 1939 only two were broken.

Other forms of accidents include the collision of automobiles with bridge railings or with principal structural members. Boat accidents usually involve collision with pier protection or damage from mast striking bridge.

Modern concrete bridges have

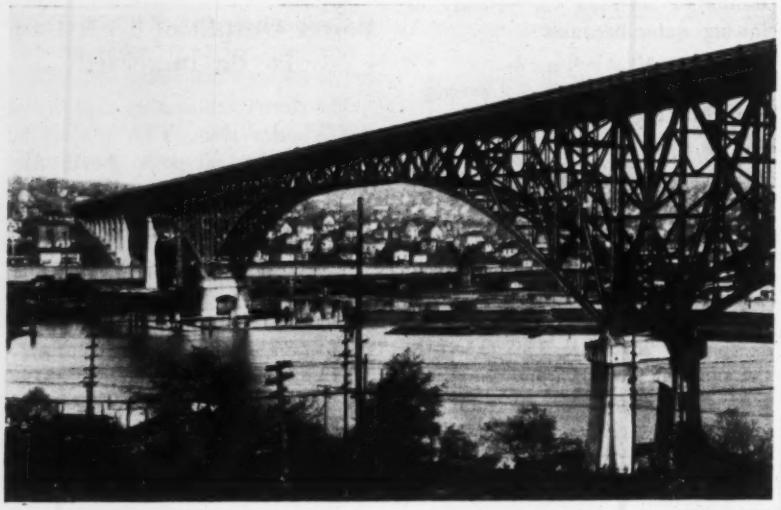


Fig. 1. Repainting the Aurora Bridge across Lake Washington ship canal is a $60,000 job.

given the city little difficulty in either maintenance or operation except in the matter of expansion joints. Difficulty on this score is reported largely a matter of design and is ascribed to the designer's assumption that his joint always will work perfectly and hence need not be made accessible.

Need accessible, sliding joints

Grease, graphite, paint or other similar materials used to protect the working surfaces of expansion joints have not been found to be effective in preventing rusting or the occasional intrusion of some obstruction into the moving space. Mr. Hubbard places particular emphasis on the importance of having expansion joints accessible for inspection or maintenance. Even those placed on top of the deck usually are not accessible. After years of service, under changing conditions of traffic and weather, conditions not foreseen in the design are frequently imposed. A simple, accessible form of sliding joint, it is believed, would greatly simplify operating requirements under the head of expansion joints.

Painting steel bridges

A coat of paint every seven years is the prescribed maintenance for Seattle's steel bridges. A lapse of nine to eleven years between paintings was found to increase the cost disproportionately. That is, if the interval is considerably more than seven years' moisture may be expected to penetrate to the metal and thereafter adequate treatment cannot be given without heavy chipping or sandblasting. This is an expense that can be avoided by timely attention. Proper time intervals add up to considerable savings: for example painting the Aurora Street Bridge is a $60,000 job.

On the newer structures, adequate preparation for painting can be given with a wire brushing, done by hand, plus some chipping off of scale here and there. When the bridge is older, that is, after it has had three or four repaintings, adequate treatment requires the use of sandblasting in at least some portions of the structure.

Checking the condition of bridges with respect to paint requirements is done by the paint foreman and the carpenter foreman working together, aided by two helpers to handle necessary rigging for the inspections.

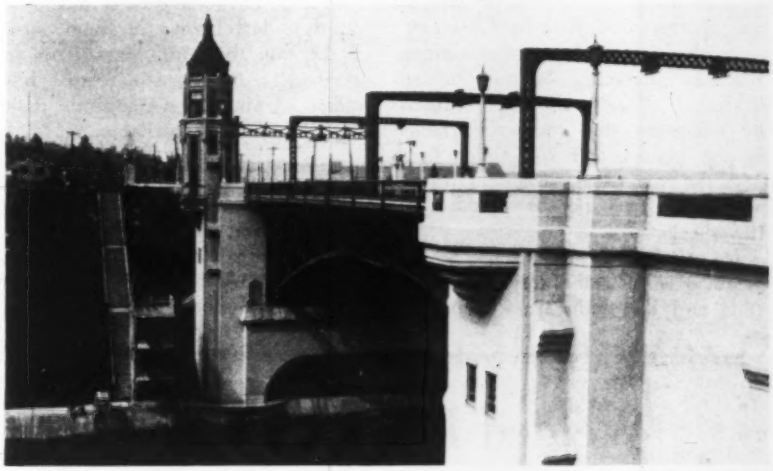


Fig. 2. Operators are on duty three shifts daily on low-level bridges like this double-leaf bascule on Montlake Ave.

This crew of four spends 10 per cent of its time in routine inspection of bridges of all classes and types.

Prior to the actual painting operation, preparatory work is done by "structural cleaners," a civil service rating applied to a class of city employees who chip and scale, touch up worn spots with red lead and oil and scrub off the paint with wire brushes where it is necessary to get to the bright metal. The structural cleaners go to work each spring and are kept on until fall. As they do not work in the rainy season they are rated as seasonal workers. From one to twelve are employed during the larger portion of the year.

Paint brushed on

Painting proper is done by crews ranging up to twelve workers, the total number varying with the season. Sprays are not used; all paint is brushed on by hand.

Two paint bases are used, namely, red lead for steel, and white lead pigment for timber. For timber, well-known brands of prepared white lead paints usually are used. For steel the city mixes its own paint in proportions that have been found best suited to requirements of Seattle climate. The batch mixes used for the steel paints are given in the accompanying table: the red lead is the undercoat and the green is the finish coat.

Timber bridges

Many of the smaller and most of the older bridges in the city are timber structures, chiefly Douglas fir. This timber has a life of 10 to 12 years in this climate. After that age, unless there has been a considerable percentage of replacement, they become dangerous. Locations where decay is most likely to start are the points where timber contacts iron. Alternate wet and dry conditions are here most destructive.

Practically no creosoted timber bridges have been put in, perhaps because the cost is almost as much as the so-called permanent construction and the obsolescent factor must not be neglected. However, creosote frequently is used on timber structures at joints and contacts where there is the greatest danger of decay.

Several of Seattle's important bridges have been entirely destroyed by fire, which is universally recognized as the greatest risk to timber structures.

BATCH FORMULAS FOR SEATTLE BRIDGE PAINT
(All figures in pounds)

	Red lead	Green
Raw linseed oil	36	44 74
Liquid dryers	4	0 81
Red lead	36	
Graphite	36	
White lead (dry pigment)		100
Chrome yellow (medium) (dry pigment)		2 4
Chrome green (dark) (dry pigment)		2 5
Lampblack		0 25
Weight per gal	15	19

Timber decks are especially hazardous: thirteen deck fires have been extinguished in one day on the wooden roadway surfacing of the Ballard bridge. Ordinarily these are caused by cigarettes that lodge in cracks in the planks, but sometimes fires near the rails of the street car tracks are started by sparks thrown off from the wheels.

On timber bridges, the Seattle practice is to paint only the handrails and the main truss members. Timber of the same quality has been found to last longer in some parts of the city than in others. This is ascribed to difference in relative humidity of air, but no accurate data on this belief are available.

Supervision

Charles L. Wartelle, city engineer of Seattle, and J. A. Dunford, bridge engineer, supervise the work of the maintenance department, which is under Mr. Hubbard's direction.

Welded Iron Waterstop For An Earth Dam

Contents in Brief—Winter construction made puddled earth or concrete core impracticable and welded sheets of iron were built up into a waterstop.

CONSTRUCTION of an earth dam with a thin sheet-iron cutoff wall is an interesting restoration operation in Rhode Island following the September hurricane of 1938. Among the devastation wrought by the storm was the felling of some 4,000,000 fbm of pine and oak timber on the Arnold estate in the northern part of the state. Such logs if stored in water will remain sound but if left lying dry are almost certain to be ruined by borers, which become active in July. To store the logs in water meant building a dam, and building it in winter in time for a 60-acre reservoir to be filled by July 1. The dam had to cost as little as possible and be built of materials at hand in cold weather.

Jenks & Ballou, consulting engineers, of Providence, R. I., were given the problem, which was to design an earth dam 450 ft. long and 25 ft. high, that could be built of pervious sand during February and March. February weather, in Rhode Island, economically precluded a concrete core, and a puddled core was out of the question, partly because small-scale rural construction could not economically exclude ice, snow and frozen earth. Therefore, the waterstop was made of sheets of Armco iron $\frac{1}{8}$ in. thick, electrically welded into a continuous sheet and set in a concrete footing (Fig. 2). These sheets were 4 ft. wide and were cut into lengths of 4, 5 and 6 ft. to break joints, to fit the profile of the site and to facilitate piecemeal assembly in the hurly-burly struggles with weather.

Fig. 1. Welding sheets of iron into a tight waterstop for a small earth dam.

The sheets were painted immediately after welding; and earthfill followed closely.

The reasoning back of this construction was simple: Expansion joints were deemed to be out of the question. In theory, as regards expansion and contraction from an assumed straight line position of the core, the ideal time for metal core installation is when weather temperatures approximate permanent ground temperatures in the completed earth dam at not less than 4 ft. below the surface of the dam; except that, in the case of expansion, slight adaptation of the earthfill resting against the core might permit minor warping of the core, whereas contraction must be wholly resisted by tension and shearing stresses in field welds. In reality, the core, as installed, not being absolutely straight, will tend to straighten by contraction and warp more by expansion. If, then, the core be welded during weather temperatures not above the permanent ground temperatures of the completed dam, the core will not be subjected to tension stress after completion of the dam.

This iron core, having been installed in winter temperatures, and soon surrounded with earth, will be subject to expansion stress only, and by a range of temperature up to that of the earth dam in summer, about 55 deg. maximum. The upper parts of the sheet-iron core, because of being welded during the moderate temperatures of March, may be subject to less temperature increase than the lower part of the core. The piecemeal progress of installation of the core favored its natural adaptation to varying weather temperatures, as contrasted with the conception of the expansion behavior of a completed sheet-iron core installed as a whole at some assumed winter temperature, and reacting, as a whole, to some assumed summer temperature. In other words, being constructed in

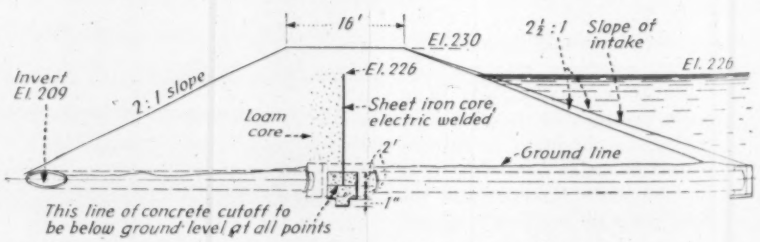


Fig. 2. Section of earth dam with a waterstop of welded sheets of iron.

winter, there is little, if any, risk of rupture of the core by contraction and a problematical risk by expansion.

Presumably, somewhat as continuous street car rails survive expansion and contraction, this slightly warping sheet-iron core may survive much smaller temperature variation. But if rupture should occur and leakage result, the seepage would appear from the three lines of 4-in. vitrified weep pipes. Further, if such seepage should become extreme, recourse would consist of coating the upstream face of the dam with loam or clay. Since this earth dam is thick in proportion to its height, the water pressures are minor and ruptures of the lapped and butt-strap joints, are likely to be few in number and of relatively slight opening.

The contractor for the dam was R. A. Bergesson, Woonsocket, R. I. The contract was awarded Feb. 8, and the dam was in service April 9, 1939.

Storage Lake Aids Stream Purification

G. M. RIDENOUR

Associate, Dept. of Water and Sewage Research
New Jersey Agricultural Experiment Station, New Brunswick, N. J.

***Contents in Brief**—Further data on the usefulness of lakes as a natural purification medium has been obtained from a long-time study of an impounding reservoir which receives the effluent from a sewage disposal plant. Storage and dilution of partly purified effluent resulted in a large reduction of biochemical oxygen demand and of bacterial population. Sludge deposit was relatively small as compared with natural silting.*

OBSERVATIONS at Greystone Park Hospital, New Jersey, over the past eight years have shown that impounding reservoirs serve a definitely useful purpose in connection with sewage treatment. Their function may be considered as either an auxiliary unit to the natural stream purification process or as a supplemental unit to the sewage treatment plant. In the first case the reservoir condenses the natural recovery stretch of the stream to a relatively short distance. In the second instance the reservoir can be considered as a final "polishing" unit of the plant.

This supplemental method of sewage treatment was started in 1932 by making use of an abandoned mill pond. The shape and area of the reservoir averages 300 ft. in width and is about 750 ft. long. Its depth at the toe of the dam is 15 ft. Exposed surface area is 225,000 sq.ft. and the estimated capacity is 2,000,000 cu.ft. The streamflow entering the reservoir during the summer averages 8.3 cfs, with a minimum of 4.7 and a maximum of 27 cfs. The average sewage flow, included in the above flow, is 1.46 cfs.

The character of this sewage effluent is that of a typical trickling filter plant operated at standard rates. The biochemical oxygen demand of the effluent varies between 25 and 40 ppm. Suspended solids average 32 ppm. During the first year of the period the sewage effluent was mixed with the incoming streamwater and introduced at location A shown in Fig. 2. During the succeeding five

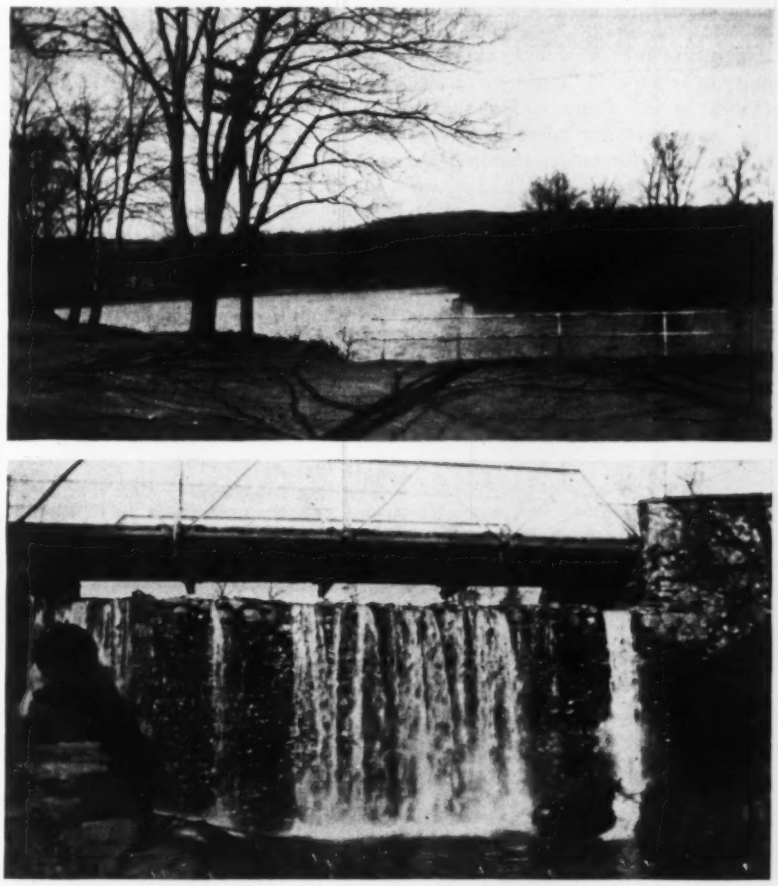


Fig. 1. Small lake used for supplemental treatment of plant effluent. Below is shown the dam overflow where further purification is effected by aeration.

years a new stream channel at B was used. In the last two years the streamwater has been kept separate from the sewage flow and rediverted to entrance A, the sewage effluent outfall being at the point indicated on the drawing.

The questions raised

When treatment of the stream-sewage mixture was started there were four major unknowns to be considered from the practical viewpoint.

With respect to possible advantages these were: (1) The reduction in biochemical oxygen demand of the stream-sewage mixture that could be effected and (2) the amount of reduction in B. coli content of the diluted sewage.

With respect to potential disadvantages the factors were: (1) the possibility of creating odors from the pond due to extreme depletion of dissolved oxygen in the water and (2) the extent to which sludge banks would form, resulting in reduction of capacity and creation of odor nuisance if removal would eventually be necessary.

The first two advantages could be more or less quickly evaluated in one season by efficiency measurements. The answer to the latter factors of sludge bank formation required the passage of several years and actual measurements of sludge accumulation. This last phase of the studies with respect to sludge banks has now been completed.

In regard to purification it was found that during the summer months the reduction in B.O.D. of the stream-sewage mixture amounted to an average of 66.5 per cent through the reservoir. During the winter the reduction was 52.5 per cent, or 14 per cent less (Table I).

TABLE I—PURIFICATION THROUGH THE RESERVOIR AS REVEALED BY VARIOUS STANDARDS OF COMPARISON

	Stream-sewage mixture		Outlet from reservoir		Below dam	
	Summer	Winter	Summer	Winter	Summer	Winter
5-day B.O.D.	13.7	15.3	4.6	7.3	—	
Dissolved oxygen ppm.	5.3	9.5	2.2	7.4	5.3	9.3
Dissolved oxygen deficit, per cent	3.4	2.0	6.4	5.2	3.4	2.0
B. coli per c.c.	38	760	9	45.4	—	

TABLE II—CHARACTER OF THE SLUDGE DEPOSITS AS SHOWN BY TOP AND BOTTON SAMPLE ANALYSES

	Top stratum	Bottom stratum	Average
Total solids, per cent	34.3	46.6	40.4
Volatile matter, per cent	14.4	11.1	12.7
B.O.D. in mg. per gm. of solids	10.7	4.6	7.7
B.O.D. in mg. per gm. vol. matter	67.5	41.3	54.4
Nitrogen—total solids, per cent	0.42	0.29	0.35
Nitrogen—vol. solids, per cent	0.29	4.53	2.42
pH value	6.3	6.2	6.2

The dissolved oxygen data shows that the water conditions, on the average, have been maintained well above the point of creating odor problems. In practice this has been borne out by the absence of any putrefactive odors from the body of water and by lack of complaints from residents of nearby properties, some of whom live within a distance of 400 ft. Actual experience has also proven that considerably less quantities of dissolved oxygen than those shown in the tables can be tolerated without odor nuisances. For instance, during a period of excessive drought in recent years the dissolved oxygen has dropped as low as 0.5 ppm. in the reservoir outlet without creating odors. Further, the recovery in the dissolved oxygen content is rapid over the dam overfall as shown by the reaeration effects in Table I.

Calculations from the data show that during the summer period 466 pounds of oxygen per day were supplied toward the purification of the sewage by atmospheric absorption and through photosynthetic processes. During the winter this dropped to 407 lb. per day. On the basis of surface area this is equivalent to 10.1 grams per square meter per day in the summer and 8.8. grams per square meter per day in the winter.

Sludge bank formation

The quantity and distribution of sludge accumulations in eight years is indicated by the contour lines in Fig. 2. Maximum depth of sludge reached in that period was 2 ft. However, 95 per cent of the deposits do not exceed 1 ft. in depth. The major precipitation of the suspended material appears to occur at two points, the first being near the inlet to the impounded water, and the second just ahead of the dam at the outlet end of the lake.

The total quantity of sediment added to the pond in eight years is by direct measurement 65,000 cu.ft. or 2,100 tons. The proportion of total sediment due only to sewage solids is estimated at 17 per cent or 1,000 cu.ft. The remaining 83 per cent is due to silt and decaying vegetation. Expressed on a unit basis, 3.9 cu.ft. of lake capacity is needed per ton of sewage solids per year, exclusive of natural silting caused by

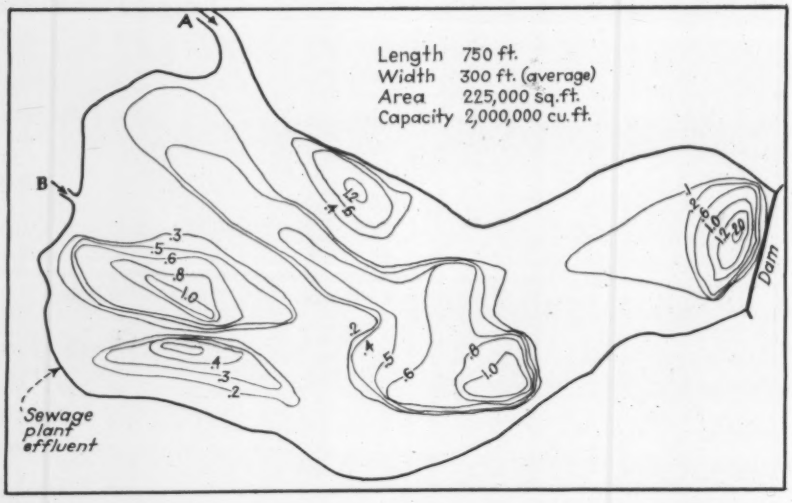


Fig. 2. Contour lines in the reservoir indicate the quantity and distribution of sludge deposition after 8 years.

stream deposition and vegetation.

The character of the deposited sludge is shown in Table II. The nature of the sediment with respect to vertical distribution showed a significantly higher stage of decomposition of the bottom stratum as against the top layer. Horizontally, the sludge deposit was practically uniform with the exception of a small area surrounding the outfalls where the volatile content and B.O.D. of the material was high.

Practical aspects

These studies indicate the capability of impounded bodies of water operating under natural conditions to serve as a unit in the process of sewage purification. Lakes are particularly applicable to purification purposes and can be so used where they are available or can be artificially created at moderate cost. Under natural conditions, with optimum loadings for the diluting water available, the reservoirs are capable of treating both dissolved organic substances in the sewage liquor as well as the suspended solids of the sewage, the former aerobically and the latter by a combination of aerobic and anaerobic processes.

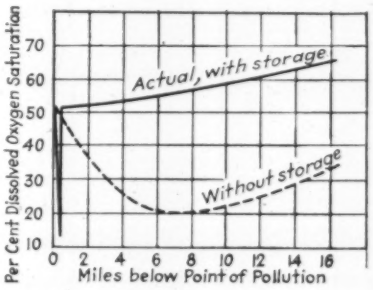


Fig. 3. Dissolved oxygen saturation in a stream with and without benefit of natural storage.

The lake storage method of treatment appears to be especially valuable as a final adjunct to previous purification processes under situations where: (1) a very high quality of streamwater is desired; (2) in situations where it is desirable to even out fluctuations in treatment; and (3) in cases where it is necessary to control the maximum depletion of dissolved oxygen in the stream to a relatively short distance. An example of the latter is given in Fig. 3 showing the calculated comparison of relative dissolved oxygen saturation values at consecutive distances downstream with and without natural storage.

Eight Radial Roof Trusses Without a Common Center

A NOVEL SUPPORT is used for the roof of the auditorium at the San Francisco World's Fair. The requirement was that there should be 3,500 seats on the main floor (no galleries) of a structure having the best possible acoustic properties. An octagonal plan was most economical; a dome roof was considered inadvisable because of risk of unequal settlement in the newly filled foundation. The roof support used consists of four pairs of radial trusses, each pair combined into a 3-hinged arch.

Each pair of trusses had to be kept entirely separate from the others to avoid developing dome action in the roof structure in the event of unequal settlement. The eight radial trusses (or half arches) are all alike except in the center panels where modification of the uniform design was necessary to bring the center pins to different levels. (Fig. 2).

Beneath the floor level each truss has a horizontal tie made of $\frac{3}{8}$x8-in. plates, pin-connected in 30-ft. lengths. Each tie, in effect, is a chain of eyebars in which the only support is a central platform carried by a single pile. A bolted connection in each chain provides means for initial adjustment of length.

The roof surface has a slope of 1 in 12. The auditorium ceiling and walls are faced with a fiber board, selected for its acoustic properties, which is attached to the wall studding and the under side of the rafters. The trusses are left exposed to view beneath the fiber-board ceiling.

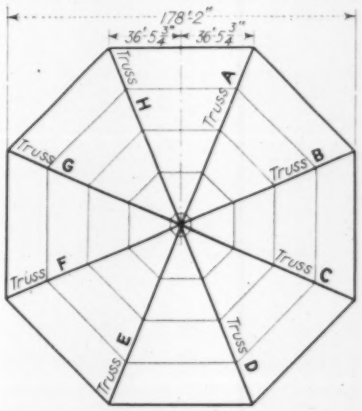


Fig. 1. Radial trusses are arranged in pairs over the octagonal.

The outer walls around the hexagon are 72 ft. high and were figured for a wind load of 15 lb. per sq. ft. and the usual seismic provision, i.e., a horizontal force of 0.1 *g*. The walls are braced to localize settlement.

The auditorium was designed by the California Commission for the Golden Gate International Exposition, C. E. Seage, assistant executive officer in charge of plans.

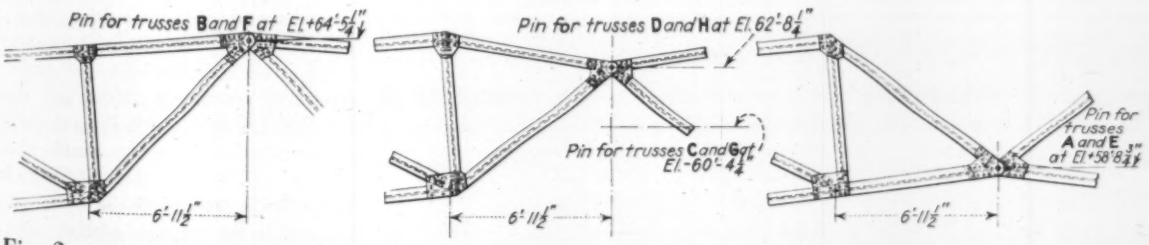

Pin for trusses B and F at El+64'-5¼"
6'-11½"
Pin for trusses D and H at El. 62'-8¼"
Pin for trusses C and G at El.-60'-4¼"
6'-11½"
Pin for trusses A and E at El+58'-8¾"
6'-11½"

Fig. 2. Center hinge elevations and joint details for eight radial trusses.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Regarding Detour Signs

CHARLES T. FOSTER
Albany, N. Y.

C. P. Fisk is correct in stating (*ENR*, May 11) that the new style detour sign (*ENR*, Jan. 19) of the

Why a detour sign was scrapped.

Pennsylvania highway department was used some years ago in New York. Perhaps an examination of the cards tacked on the one shown in the enclosed picture will indicate the reason why this type of sign was abandoned. The picture was taken near Hancock, N. Y., in 1924.

• • •

Steel Piles Made of Old Rails

A steel pile now used extensively for foundations, bridge abutments and piers along railroad lines of the Southern Pacific Co. is made up by welding together old rails in groups of three. The heads are grouped, as shown in the accompanying sketch, welds 2 ft. long are made at each end and at 2-ft. intervals welds 6 in. long are put in on all three sides to hold the assembly together. Ordinarily 30 ft. in length, piles up to 39 ft. long made up in this way are used with good success.

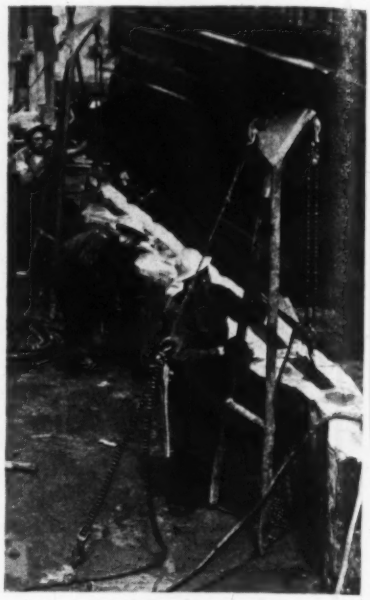
This method of using old rail was developed by the engineering department of the Southern Pacific Co., W. H. Kirkbride, chief engineer.

• • •

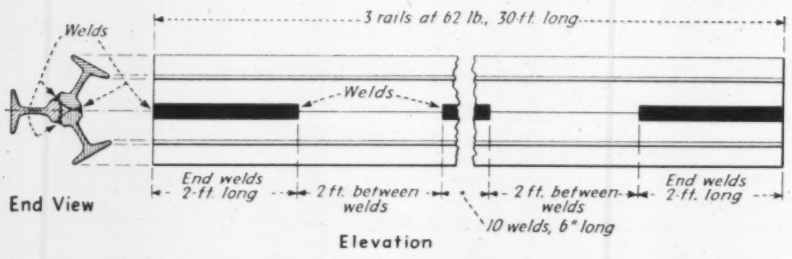
Handy A-Frames for Form Panels

A-frames for raising the 25-ft. form panels on Grand Coulee Dam are made up with 2-in. pipe welded up on the job according to a design that has proved to be satisfactory. A notable feature is the oak filler put inside the pipes at the upper end of the A-frame where each pipe is bent on an 18-in. radius. The wood prevents the pipe from kinking as it is bent. The primary function of the A-frames is to support the ratchet jacks with which the form panels are lifted 5 ft. for successive concrete pours. The need is for a rig of light weight which can be easily set up and is simple to operate.

These requirements are met by a simple A-frame, as shown in the illustration, which gives a clear height of 7 ft. in the slightly inclined working position. To the upper end of the frame is welded a steel plate at whose forward end is the support for the ratchet jack that lifts the form. At the rear of the plate is a cable running down to another ratchet jack connecting to one of the "hairpins" (½-in. reinforcing bars) anchored at convenient intervals in the concrete. Bottoms of the A-frame legs are brought to a blunt point to facilitate holding any position in which the frame is set up. The rig is so light that it is easily moved about and frequently is set up for various lifting operations other than handling forms.



A pair of welded A-frames making a 5 ft. lift on one of the 25 ft. concrete form panels.



Section and elevation of steel pile made by welding together old railroad rails.

FIELD & OFFICE COMMENT

Computing Pile Groups

Sir: The writer notes with interest the article by Charles E. Sharp, Jr., in *Engineering News-Record*, Aug. 3, 1939, entitled "Computing Pile Groups," in which is presented a simple formula for computing the section modulus of symmetrical pile or rivet groups. Mr. Sharp claims to have developed the formula.

As a matter of record the writer desires to state that a formula identical to that given by Mr. Sharp was developed by the writer in the year 1919 in the office of Harrington-Howard and Ash, consulting bridge engineers. The formula was given to many other engineers in that organization from time to time and was used in various computations since its development. The writer recalls that several years later than in 1919 a C. E. Sharp was employed by the organization for a period of time.

The formula as given in the article:

$$\text{Section Modulus} = \frac{s\,N\,(N+1)}{6}$$

is, as indicated, quite accurate for a single line of rivets or piles uniformly spaced.

When there are several rows or lines of piles or rivets arranged in a symmetrical manner, with uniform number of piles or rivets in each line, the section modulus of the whole group about its centerline will be equal to the section modulus for one line or row multiplied by the number of lines or rows.

Such a section modulus may be computed about one centerline which we may designate as the x axis. Call this section modulus Kx. The centerline in the opposite direction may be designated as the y axis. The section modulus about the y axis we will designate as Ky.

The maximum stress from moment in a group of rivets will in certain cases be on one of the corner rivets, and is equal to the moment divided by the polar section modulus. The polar section modulus may be obtained in a simple manner by combining the section moduli Kx and Ky as follows:

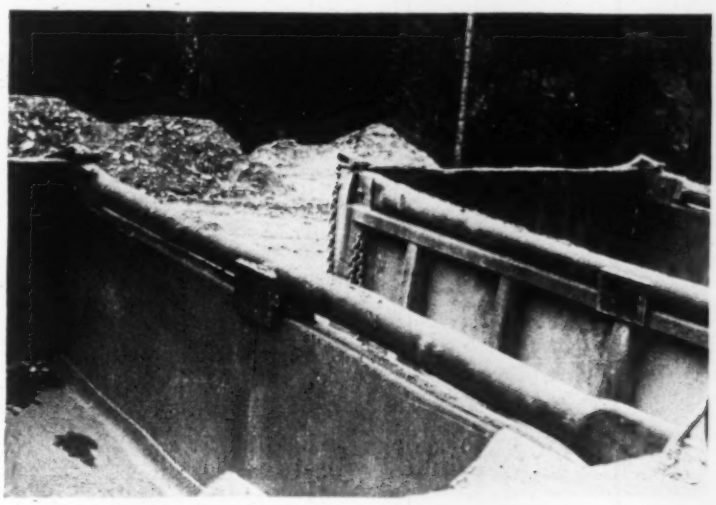
$$\text{Polar } SM = \sqrt{Kx^2 + Ky^2}$$

Further applications have been made by the writer in easy and accurate calculations of rivet groups similar to the uniformly spaced rivets discussed above, but in which some of the rivets are omitted so that spacing is not uniform. This requires first, the computation of section modulus of a symmetrical group as if rivets were used throughout in a uniform spacing, then the separate computation of section modulus of the group of rivets to be omitted from the pattern, and then the deduction of this latter SM from the first SM to obtain desired actual net SM. However, before making such deduction the SM to be deducted must be multiplied by the ratio of distance from neutral axis to the extreme rivet of deducted group to the corresponding distance to the extreme rivet of the entire group.

Similar applications have been made in computation of the net section modulus of a plate perforated with a number of holes along a section where stress investigation is to be made.

The writer is glad to see the formula brought to the general attention of the profession since it is easily memorized and much simpler in application than the methods commonly presented in text books.

CARL S. HARPER
Chief Draftsman,
Ash-Howard-Needles & Tammen
Kansas City, Mo.



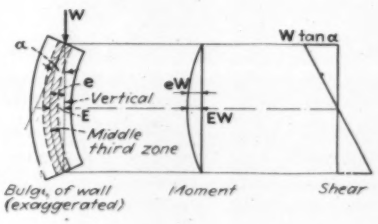
CAMERA MEMORANDA

An effective buffer to take the battering of heavy rock loaded from power shovels into 10-cu. yd. trucks on the Ruby Dam job has been formed by top rails of 4-in. pipe on the truck sides. These rails have a ½-in. plate welded on each side of the pipe, mid length, so as to just clear the truck sides thus holding the pipe in place at the center. At each end the pipe is flattened to facilitate bolting it to the truck body. It can be replaced easily.

Safe Bulge in Walls

Sir: In *From Field and Office* for June 22, 1939, C. B. Dannenberg sets forth a criterion for the safe bulge of a wall. He states that because tension will ultimately lead to failure, the permissible bulge must be sufficiently small to insure the absence of tensile stresses. Certainly a wall with a greater bulge than this is unsafe, indeed one may doubt that the limit set is low enough.

However, accepting it as an upper limit and considering the figure given by Mr. Dannenberg: for the superimposed load W to produce no tension, it is well known that its line of action must lie within the middle third of the wall. This determines the maximum allowable bulge, E, directly as one-sixth the thickness T.



The derivation of this result given in the article is, therefore, not required, and in addition is misleading and somewhat in error. The moment produced at any section by W is equal to W times the distance between the centroid of the section and the line of action of W $(= eW)$. As W acts vertically, the curve of bulge and the projected moment diagram will have exactly the same shape. This is shown in the accompanying diagrams. At the center the moment is EW as given by Mr. Dannenberg, but the variation is not the linear one shown on his diagram.

If we define the shear at any section in the usual manner as the component of W acting parallel to the section, the shear diagram will vary as the inclination of the curve of bulge to the vertical. If this curve is parabolic the projected diagram will be linear, if the bulge is of some other shape, the shear diagram will be curved, but for a symmetrically curved wall, the shear at the point of maximum bulge is always zero and at the ends is $W \tan \alpha$ $\left(\text{not } \frac{W}{2} \tan \alpha\right)$.

DANIEL C. DRUCKER
New York, N. Y.

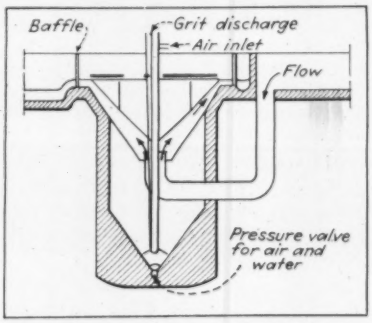
Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

SLUDGE BULKING — Observations seem to indicate that the presence of excessive quantities of carbonaceous materials in sewage causes increase in growth of *Sphaerotulus* with resulting bulking in the aeration units of the activated sludge plant. Excessive growth of this fungus has been observed especially when milk wastes are discharged. Studies on the various biological growths (*Report*, Water Pollution Research Board, England, 1938) in the aeration tanks receiving whey washings in addition to milk washings showed a change in the species of the living organisms found in the sludge. When whey was added the *Sphaerotulus* decreased greatly, and on several occasions bulking occurred. Deterioration of the sludge was not due to an excess of *Sphaerotulus* because the floc was easily broken up; this was perhaps facilitated by the absence of the fungus which tends to increase the strength of the floc. Observations showed that when whey was present the bacteria did not form zoogleal masses as readily as when milk washings alone were treated. It appears that the type of bacteria may be of more importance in bulking than the much-blamed fungus.

IMHOFF TANKS—At many places Imhoff tanks have given considerable trouble during operation. Nearly everything—from fats and grit in the sewage to climatic and atmospheric conditions—has been blamed for the difficulties. Most of the trials and tribulations, however, can be attributed to insufficient sludge digestion capacity. That Imhoff tanks will work and perform properly when sufficient capacity is available has been demonstrated in practice. Allen (*Annual Report*, Fitchburg, Mass., 1938) makes his oft-repeated statement that "the tanks have been operated successfully throughout the year with a well settled sewage delivered to the trickling filters." The detention period employed averaged 4½ hr. Experience has shown that operation troubles, foaming and odors are directly related to the sludge capacity of the tanks: the smaller the available storage, the greater the difficulties.

GRIT CHAMBERS—The last word on grit chamber design has not been printed as yet. Grit chambers retain either too much material or not enough. Even in modern well-operated chambers the grit may contain from 5 to 50 per cent volatile matter. In many places the grit contains sufficient combustible matter to allow it to be incinerated without auxiliary heat. An extensive study on grit chambers by Lohff (*Gesundheits Ingenieur*, May 20, 1939) led to a design which he believes to be theoretically the best possible, based on all modern conceptions and calculations. No example has been built as yet. (See sketch.)

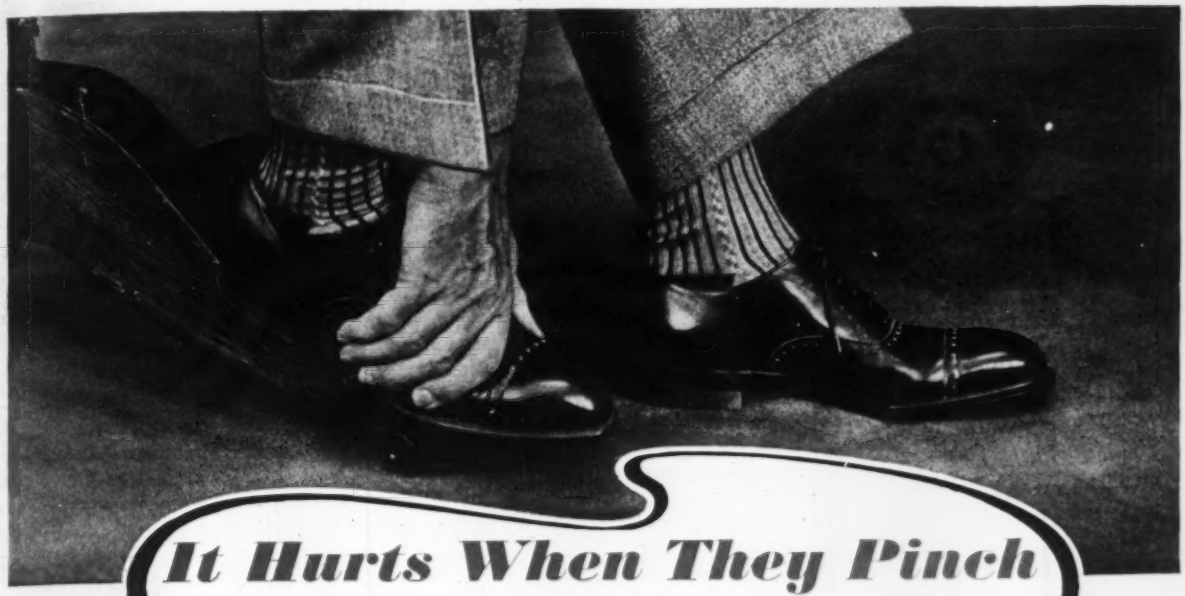


MILK WASTE TREATMENT—Milk waste continues to be one of the difficult and costly wastes to treat. Various methods, including trickling filter, activated sludge and chemical treatment have been used with considerable success. Comparison of two biological methods is of considerable interest, therefore, from the standpoint of cost and efficiency. Results on double filtration, on trickling filters and by the activated sludge process (*Report*, Water Pollution Research Board, England, 1938) show that milk washings after sedimentation and dilution (if necessary) with purified effluent to give the mixture a B.O.D. of 200 to 300 ppm could be satisfactorily purified when passed through two trickling filters at a rate of 160 gal. per cu. yd. per day of filter medium. Under these conditions a final effluent with a B.O.D. of less than 10 ppm could be obtained. For short periods the washings could be treated at a rate of 240 gal. per cu. yd. per day.

In the activated sludge plant a well purified effluent with a B.O.D. of 10 ppm was obtained from milk washings having a B.O.D. of 500 ppm after settling and diluting the mixture during 24-hr. continuous operation. Results on treatment of whey and milk washings mixed in various proportions passing through double filters using the same rates of flow show that an average effluent with 4 ppm B.O.D. could be obtained. The behavior of the plant was the same as with milk washings only. When the relation of whey washings to milk washings was increased to 3:1 and an average B.O.D. of 340 ppm. the final effluent contained 7 ppm B.O.D.

Although the filters were not badly ponded they had an accumulation of surface growth which was removed by circulating treated effluents through them for 15 days. During the coldest months of the year, using a mixture of milk washings, whole whey and canal water the average B.O.D. of the effluent was 9 ppm. Whey washings alone give similar results. The activated sludge plant produced practically the same results with various mixtures. For operation under factory conditions double filtration is more suitable than the activated sludge process. Capital cost for filters is smaller for same load and the process is not easily upset by overloading.

GARBAGE AND SOAP—Leaving out hog feeding, only a fraction of the garbage produced in this country is partially reclaimed. Nevertheless, of the 764 million pounds of inedible tallow used in the United States for soap making over 500 million pounds or about 70 per cent comes from the refuse of cities, collected principally from restaurants, hotels, chain stores, boarding houses, etc. The remaining 30 per cent comes from packing houses, where it is made from condemned carcasses or parts of carcasses. Only about 40 million pounds of rendering fats are used for axle greases and the like. (From the *Congressional Record*).



It Hurts When They Pinch

Just as a tight shoe hurts the foot, so a "misfit" groove in a sheave or drum causes damage to wire rope. In one case, comfort is sacrificed—in the other, economy.

The illustration below shows a sheave groove that has been worn down fully ½ of an inch. The worn part of the groove is narrower than was the original groove contour—due to the rope also having been reduced in diameter by wear. As the proper size gauge does not go to the bottom of this worn groove, a new full size rope put on this sheave in its present condition would be severely pinched and deformed.

You will get longer rope service, and therefore greater economy, by using sheaves and drums with grooves of correct design and size. They should be large enough for the wire rope to fit into them easily without binding on the sides, but not too large, as such a groove will not give proper support to a rope.

When grooves wear deeper and narrower . . . or when the tread becomes corrugated, they should be regrooved. Oftentimes it will pay to install new sheaves. Make it a rule to check your grooves for size and condition at regular intervals—and especially before putting on a new rope.

The recommended diameter of groove for any given size rope is the nominal diameter plus a certain necessary clearance. Anything larger will not give adequate support to all ropes, and anything smaller will cause some ropes to be pinched. These groove diameters for various size ropes are as follows:

Nominal Diameter (d)	Proper Groove Diameter
0—3/4	d + 1/16
13/16—1-1/8	d + 5/64
1-3/16—1-1/2	d + 3/32
1-9/16—2-1/4	d + 1/8
2-5/16 & up	d + 3/16

This advertisement is published for the purpose of helping all wire rope users obtain safer and more economical service from their wire rope

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CROSBY
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IS SAFEST

The Genuine CROSBY WIRE ROPE CLIP is designed to grip wire rope securely without injuring it; Drop Forged from finest steel and Hot Galvanized.

IT IS THE CHEAPEST CLIP, BECAUSE IT IS THE SAFEST CLIP.

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Western Electric
VOICE-POWERED TELEPHONE

Made by Bell Telephone makers, this simplified telephone, complete with signaling device, is in one unit, only 3"x 3"x 2½". For installation simply string a pair of wires between points on the job—connecting the telephone is a matter of seconds. Send for details today.

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Gentlemen: Please send me bulletin describing the new Western Electric 10A Voice-Powered Telephone.
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ABSTRACTS AND NOTES

Mexico to Spend 8 Million On Highways in 1940

Mexico is to invest $8,000,000 in highway works, mostly construction, in 1940, according to the Ministry of Communications and Public Works. The Federal Administration will supply $5,000,000, and the state governments the remainder. Particular attention is to be given to construction of roads between Mexico City and the Suchiate on the Guatemalan border, which is part of the Pan American Highway.

• • •

Texas State Survey Work

One line of activity of the Reclamation Department of Texas is surveying and topographic mapping as a primary requisite in reclamation and conservation for flood control, levees and drainage works. From the report of Ralph J. McMahon, state reclamation engineer, it appears that in the two years 1937–1938 there were 486 sq. mi. mapped, together with 474 mi. of primary traverse and 515 mi. of primary leveling, bringing the total work of this kind by the department up to 3,078 sq. mi. mapped, 5,037 mi. of traversing and 5,096 mi. of levels. The methods of work and computation are those of the U. S. Geological Survey. Much of the recent work has had financial assistance from county and city authorities. For example, the rapid growth of the city of Corpus Christi necessitated a comprehensive plan for drainage of the city and of certain adjacent areas that will be annexed to it. At the request of the city officials the department established primary traversing and leveling for a detailed survey. This work was completed in 1938 with detailed maps on a scale of 1 in. to 500 ft., and the city paid $2,390 towards the expense.

In all such work, as well as in topographic mapping, land surveys and hydraulic studies for levee districts and other purposes, the results are published in bulletin form and are made available to engineers and others interested at a charge just sufficient to cover the cost of printing and postage. This price has now been reduced by mimeographing the bulletins instead of printing them. Several of these bulletins list the benchmarks established in different portions of the state, based on the triangulation work of the U. S. Coast and Geodetic Survey. Each benchmark is described, together with its latitude, longitude and sea-level elevation.

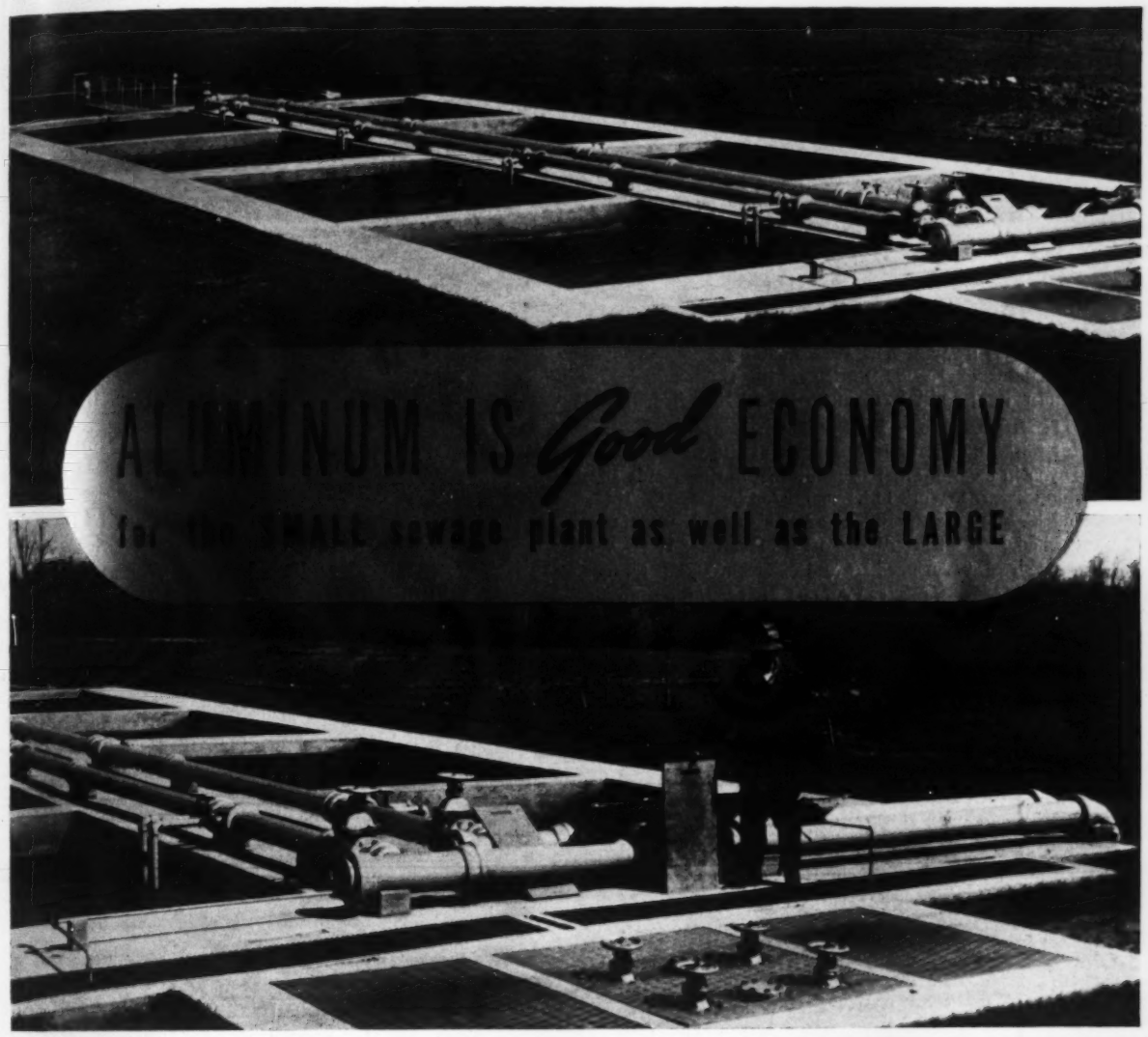
• • •

Men Trained For City Hall Jobs

Eighteen cities report successful use of the apprentice system to train recruits for administrative jobs in municipal government, according to a study released by the International City Managers Association. Including Cincinnati, Ohio, which has 87 municipal university students working part-time in the city hall, the 18 cities employ a total of 108 apprentices, the study showed. Other cities in the group include Dallas and Wichita Falls, Tex., and Stoughton, Mass., which have been training apprentices since 1934; San Diego, Calif., Toledo, Ohio, Morgantown, W. Va., Beloit, Wis., and Westerville, Ohio.

The administrative job-learners all are college graduates, educated mainly in political science, public administration or engineering. During the job-training period, which may last one year or longer, the apprentices work for salaries ranging from $50 to $175 a month. Their duties vary. San Diego assigns them to staff work under supervision of the budget office. Dallas treats apprentices as regular employees and assigns them to various phases of work in city departments. In Wichita Falls the apprentice assists the city manager in preparing the annual budget, makes special studies of revenue and expenditures, keeps personnel records and answers routine correspondence.

Ten of the cities said that their apprentices enter training with the understanding that satisfactory work will gain them permanent appointment. Eight former apprentices of these cities later became city managers, the report said. Others took municipal appointments such as engineer, housing authority official and general clerk. A number went into state service. Only three changed their fields to private business following their apprentice training periods.



Grating, stop gates and diffuser plate holders are Alcoa Aluminum at Berea's new sewage treatment plant

Berea, Ohio — population about 6,000 — has recently placed its new sewage treatment plant in operation. Alcoa Aluminum Alloys and Aluminum Paint are used here, just as they are in many other plants throughout the country, to combat corrosion and maintain efficiency.

Using Aluminum is equally good economy in the small and large plant. Burger diffuser plate holders illustrate how Aluminum helps to hold down operating costs.

Cast of Alcoa Aluminum, these holders are light in weight, requiring little effort to lift in and out of the aeration tanks. The Burger design simplifies installation and removal of diffuser plates; several bolts hold plates in place, while long-lived rubber gaskets make them permanently air and water-tight. There is no formation of rust to cause clogging of plates. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Bldg., Pittsburgh, Penna.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

STEVENS DAM, WASHINGTON

OWNER: U. S. Engineer Office, Central Building, Seattle, Wash. Col. L. E. Atkins, district engineer.

PROJECT: Construction of Stevens (Mud Mountain) rolled-earth fill dam on White River, 6 miles east of Enumclaw, Wash., 47 miles from Seattle. Dam to be about 400 ft. high, with overflow spillway 300 ft. wide. Includes 23-ft. diameter concrete-lined tunnel 2000 ft. long with trashracks, penstocks and valves; and 9-ft. diameter tunnel 1800 ft. long.

CONDITIONS: Dam to be built in narrow canyon with little room for working operations. Surveyors at site were lowered into canyon in cage in order to map area. Spring floods add to working hazards. Work to be completed by Nov. 15, 1942. Rail and highway transportation available. All materials to be furnished by contractor. Wage rates: skilled, $1.85 per hr.; semi-skilled, $1.25 per hr.; and common, 90c. per hr.

BIDS: Two bids were received August 21, 1939, the contract low of $5,344,605, and $7,270,390.

LOW BIDDERS:

1. G. F. Atkinson, San Francisco, Calif.....$5,344,605
2. Columbia Constr. Co., Westport, Wash..... 7,270,390

Item	Quan.	Unit Prices (1)	(2)
1. Divers., care of river	L.S.	$98,000 00	$145,000 00
2. Divers., care of drainage	L.S.	2,500 00	5,000 00
3. Excav. common	210,000 c. y.	1.00	1.50
4. Excav. riverbed	80,000 c. y.	.70	1.80
5. Excav. spillway	1,140,000 c. y.	.75	.45
6. Excav. borrow	3,450,000 c. y.	.20	.47
7. Excav. tunnel portals	7,500 c. y.	2.00	4.00
8. Excav. trenches	2,600 c. y.	2.25	10.00
9. Excav. rock tunnel portals	25,000 c. y.	2.00	6.25
10. Excav. rock riverbed	30,000 c. y.	1.50	6.25
11. Excav. rock canyon walls	30,000 c. y.	3.00	6.25
12. Excav. rock spillway	3,000 c. y.	3.00	5.25
13. Excav. rock trenches	600 c. y.	8.00	12.50
14. Excav. rock 23-ft. tunnel	45,000 c. y.	14.00	11.00
15. Excav. rock 9-ft. tunnel	8,000 c. y.	14.00	25.00
16. Tunnel protection	200 M.bm.	100.00	200.00
17. Rolled fill	2,275,000 c. y.	.24	.30
18. Dumped fill	660,000 c. y.	.20	.25
19. Additional rolling	400,000 s. y.	.025	.01
20. Compacted backfill	300 c. y.	5.00	12.00
21. Compacted spillway	100 c. y.	4.00	6.00
22. Dumped riprap	38,000 c. y.	3.50	3.25
23. Hand-placed riprap	1,000 c. y.	10.00	14.00
24. Derrick stone	28,000 c. y.	4.00	4.50
25. 4-inch spillway drains	9,000 l. f.	.90	1.65
26. 8-inch spillway drains	4,400 l. f.	1.40	2.50
27. 10-inch spillway drains	500 l. f.	2.00	3.50
28. 14-inch spillway drains	150 l. f.	3.00	4.50
29. Grout tunnels, canyon wall	2,150 c. y.	1.00	1.00
30. 2-inch drill holes	2,800 c. y.	1.00	4.00
31. Pressure grouting	7,000 c. f	2.50	4.50
32. Line drilling	5,000 s. f.	2.00	.80
33. Concrete walls, backfill	1,540 c. y.	16.00	30.00
34. Concrete tunnel portals	1,240 c. y.	12.00	40.00
35. Concrete intake	1,200 c. y.	40.00	45.00
36. Concrete valve house	100 c. y.	35.00	50.00
37. Concrete tunnel plug	2,507 c. y.	18.00	20.00
38. Concrete penstock	400 c. y.	16.00	35.00
39. Concrete spillway	26,000 c. y.	16.00	15.00
40. Concrete 23-ft. tunnel	12,000 c. y.	16.00	19.00
41. Concrete 9-ft. tunnel	3,000 c. y.	20.00	25.00
42. Concrete shafts	1,000 c. y.	24.00	40.00
43. Copper stops	20,500 l. f.	.90	1.50
44. Reinforcing steel	2,800,000 lbs.	.045	.065
45. Steel penstocks	2,800,000 lbs.	.08	.135
46. Steel trashracks	115,000 lbs.	.08	.14
47. Steel rails	800,000 lbs.	.035	.065
48. Misc. metal	35,000 lbs.	.20	.33
49. Cast steel conduits	163,000 lbs.	1.25	.23
50. Steel lining, 9-ft. tunnel	360,000 lbs.	.10	.15
51. Slide gate	1 ea.	2,000 00	3,000 00
52. Valves and equipment	3 ea.	32,500 00	45,000 00
53. Radial gate	1 ea.	9,000 00	15,000 00
54. Valve house equipment	L.S.	1,000 00	2,000 00
55. Class C concrete	150 c. y.	50 00	120 00
56. "A" cement mortar	2,000 c. f.	4 00	12 00
57. "B" cement mortar	150 c. f.	8 00	32 00
58. 24-inch cast iron valve	1 ea.	1,200 00	2,000 00
59. 10-inch cast iron valve	1 ea.	200 00	300 00
60. Cast iron fittings	6,000 lbs.	15	.50
61. Fishway grill	500 s. f.	60	1 00
62. Fishway timber lining	3 M.bm.	150 00	225 00
63. Fishway baffles	5 M.bm.	200 00	300 00
64. Test pits, 0 to 20-ft.	1,000 l. f.	10 00	25 00
65. Test pits, 20 to 40-ft.	500 l. f.	12 50	30 00
66. Test pits, over 40-ft.	500 l. f.	15 00	40 00

BRIDGE
MARYLAND AND VIRGINIA

OWNER: Maryland State Roads Commission, Baltimore; L. H. Steuart, secretary. J. E. Greiner Co., Baltimore, Md., engineers.

PROJECT: Superstructure, Contract 4, Potomac River Bridge, between Ludlows Ferry, Md., and point near Dahlgren, Va. Consists of I-beam spans, continuous girders of Wichert design.

CONDITIONS: Contractor to furnish all materials. Project to be completed by June 20, 1940. Water transportation available. Wage rates are: skilled, $1.10 to $2.50 per hr.; semi-skilled, $1.00 per hr.; and common, 70c. per hr.

BIDS: Five bids opened in May, 1939, ranging from the contract low of $1,975,517 to $2,206,103.

LOW BIDDERS:

1. Harris Structural Steel Co., Inc., New York. N. Y. (contract).....$1,975,517
2. American Bridge Co., Pittsburgh, Pa..... 1,975,967
3. Bethlehem Steel Co., Bethlehem, Pa..... 2,154,868

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Struct. carbon steel	20,500,000 lb.	$0 069	$0 0686	$0 075
2. Struct. silicon steel	3,630,000 lb.	.0735	.0761	.081
3. Steel castings	115,000 lb.	.0925	.1145	.13
4. Forgings and forged pins	50,000 lb.	.095	.119	.18
5. Malleable iron castings	112,000 lb.	.07	.10	.085
6. Bronze plates	2,300 lb.	.53	.598	.61
7. Sheet lead	5,200 lb.	.10	.104	.11
8. Reinforcing steel	515,000 lb.	.05	.046	.0475
9. Conc. filled roadway floor	155,500 s. f.	1.09	1.10	1.20
10. Cl. A conc., roadway slabs	2,350 c. y.	30.00	27.00	30.00
11. Facilities for engineer and inspector	L.S.	3,500.00	3,000.00	4,030.00

UNDERPASS, MARYLAND

OWNER: State Roads Commission of Maryland, Baltimore.

PROJECT: Construction of underpass beneath Western Maryland Railway, on proposed new street west of Elizabeth Street grade crossing, Hagerstown, Md. Steel and concrete construction. Single 40-ft. span, I-beam bridge.

CONDITIONS: Transportation by rail and highway available. To be completed in 225 days. Wage rates on project are: skilled 56c. per hr.; semi-skilled, 45c. per hr.; and common, 35c. per hr.

BIDS: Seven bids were received June 6, 1939, ranging from the contract low of $162,518 to $184,490.

LOW BIDDERS:

1. Frank Carozza & Sons, Baltimore, Md.....$162,518
2. The Aldwyn Corp., Bryn Mawr, Pa..... 162,622
3. Robert L. Oates, Baltimore, Md..... 164,965

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Class 2 excav	15,100 c. y.	$1 55	$0 90	$1 15
2. Class A concrete, std	135 c. y.	15 00	18 00	22 00
3. Class A conc. HES cem	780 c. y.	15 00	22 00	17 20
4. Class B concrete	1,610 c. y.	11 00	15 90	13 85
5. Reinforcing steel	102,000 lb.	.034	.049	.05
6. Fabr. struct. steel	705,000 lb.	.026	.045	.04
7. Stone backfill	210 c. y.	6 00	4 00	3 00
8. Tamped fill	4,600 c. y.	.50	.25	1 30
9. Select. backfill material	3,200 c. y.	1 50	2 00	1 30
10. Expan. material, bridge	L.S.	1,000 00	1,400 00	500 00
11. Protec. coat. conc. work	L.S.	3,400 00	3,500 00	3,900 00
12. Istall conduits	L.S.	400 00	450 00	260 00
13. Temp. track supports	L.S.	45,000 00	34,240 00	36,975 00
14. Contingent sub-ft. conc	2,200 c. y.	9 00	7 60	8 75
15. Contingent sub-ft. excav	2,200 c. y.	3 60	1 10	1 80

CORBETTA CONSTRUCTION CO., concrete contractors for Queens Bridge Housing Development, Long Island City, New York, saved a nice piece of change by using 'Incor' 24-Hour Cement.

Erected for New York City Housing Authority, this huge $15-million USHA-financed project consists of 96 six-story units—brick masonry with concrete floors. It took 5 days to bring masonry up to floor levels, so in this instance there was no economy in using 'Incor' throughout.

But alert Corbetta Construction Co., experienced in using 'Incor' on other jobs, saw a chance to effect a saving: They formed one complete set of floors for 36 of the 96 units; then used 'Incor' for the roofs, in order to re-use forms without loss of time. Forms were stripped in 24 hours and immediately re-used. 'Incor' saved 7 working days.

Overhead was $500 a day, so the 7-day 'Incor' saving meant $3500. Extra cost of 'Incor', $1258. *Net saving, $2242—or $1.79 on each of 1254 cu. yd. of 'Incor' concrete. Nice money, that!*

Further proof that it pays to use 'Incor' wherever dependable 24-hour service strength shows a net saving; elsewhere, use Lone Star—quality standard ever since 1900. Write for copy of "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2284, 342 Madison Avenue, New York. *Reg. U. S. Pat. Off.

Sales Offices: ALBANY, BIRMINGHAM, BOSTON, CHICAGO, DALLAS, HOUSTON, INDIANAPOLIS, JACKSON, MISS.; KANSAS CITY, NEW ORLEANS, NEW YORK, NORFOLK, PHILADELPHIA, ST. LOUIS, WASHINGTON, D. C.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

SEPTEMBER construction material prices again show only minor changes from the preceding month. Short Leaf Yellow Pine is $1.00 to $2.00 higher on most 1- and 2-in. sizes in Chicago; $1.00 to $2.50 higher in Cleveland; $1.00 higher on the 2x6-in. size in Detroit; but off 50c. on the 2x4-in. size in Atlanta. Douglas Fir is up $1.00 to $2.00 on most sizes in Chicago, but timbers are $1.00 lower in Montreal. Long Leaf Yellow Pine timbers are higher in Atlanta, Cleveland, Detroit and Kansas City.

New billet reinforcing bars are up 6c. per 100 lb. in Atlanta, but 15c. lower in Cleveland, Minneapolis and Pittsburgh.

Sand is down 20c. per ton in Cincinnati. Brick, common, is 30c. per M. lower in Detroit. Hydrated finishing lime is off 60c. per ton in Montreal. Dry Red Lead is 50c. per 100 lb. higher in all 20 cities.

Slate surfaced roofing rolls are 8c. per sq. higher in New York, but 10 and 25c. lower, respectively, in Boston and Chicago. Paving asphalt is down $1.00 in Baltimore and New York. Granite paving blocks are off $5.00 per M in Boston, but $10.00 higher in Chicago.

Wage rates for skilled and common labor in all 20 cities remain at the August levels.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50 c.y. or more, delivered)
	Cloth Bags[a]	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75[b]	2.50[b]	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75[m]
Chicago	2.75	2.50	2.35	2.15‡[d]	2.15‡[d]	2.15‡[d]	2.15‡[d]	2.15‡[d]	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45[i]	1.45[i]	1.45[i]	1.60[i]	1.60[i]	1.70[i]	1.70[i]	6.85[i]
Dallas	2.30	2.05	1.85	2.00[p]	2.00[p]	1.50[p]	1.69[p]	1.84[p]	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.80	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90[n]
Los Angeles	2.82[b]	2.62[b]	....	1.00	1.00	1.00	1.00[f]	1.00[f]	....	....	5.85
Minneapolis	3.00	2.75	....	1.00[h]	1.00[h]	.25[h]	1.00[h]	1.00[h]	....	....	7.35[j]
Montreal	....	....	1.48	....	....	1.25‡	.90‡[c]	1.00‡[c]	....	....	7.60[l]
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40[de]	1.40[de]	.90[de]	1.65[de]	1.75[de]	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95[k]
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85[h]	.85[h]	.75[g]	.75[g]	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95[o]	2.70[o]	....	1.00[o]	1.00[o]	1.00[o]	2.00[o]	2.00[o]	....	....	7.50[o]

‡ Delivered. [a] 10c. allowed for each returnable bag. [b] 10c. per bbl. off for cash. [c] Plus municipal tax. [d] Per cu. yd. [e] Barge lots alongside docks [f] Crushed granite. [g] F.o.b. Granite City, Ill. [h] F.o.b. plant. [i] Within three miles of Public Square. [j] 5% discount for cash. [k] Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. [l] Up to 200 cu. yd. [m] 50c. off for cash. [n] 25 c.y. or more. [o] 2% off for cash. [p] 10c. per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS: Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	PAVING ASPHALT: Per ton less than 80 penetration, Tank car	Drums	ASPHALT BINDERS—FLUXES: Per gal. 80–300 penetration, Tank car	Drums	CUTBACK ASPHALT: Per ton, Tank car	Drums	ROAD OILS: Per gal., Tank car	ASPHALT EMULSION (Quick-breaking): Per gal., Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60[e]	$21.80[e]	$0.0645[e]	$0.0945[e]	$0.0684[he]	$0.0984[he]	$0.0584[e]	$0.0684	$0.0684
Baltimore	140.00‡	44.00‡	2.50	12.00	17.00	.045	.07	.055[h]	.08	.....	.....	.....
Birmingham	.....	25.00	.....	18.20	23.20	.0747	.1047	.0834[h]	.1134[h]	.....	.....	.....
Boston	75.00	47.00	3.00	13.00	18.00	.05	.08	.06[h]	.09[h]	.....	.09‡	.12‡
Chicago	150.00	52.00	1.80[d]	14.00	18.00	13.00[g]	17.00[g]	.055	.105	.0275	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07[h]	.085[h]	.035	.08	.09
Dallas	.....	30.00	.....	12.00	17.00	.04	.07	13.00	18.00	.035	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.60[f]	18.00[f]	.0593	.0994	13.60	18.00	.0535	.0567	.0824
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077[h]	.107[h]	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50[b]	15.00	6.50[b]	15.00[g]	5.50[b]	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90[d]	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	82.00	.....	3.62	14.60	21.25	.105	.1375	.101[h]	.121[h]	.0935	.13	.16
New Orleans	.....	.....	.....	14.00[a]	19.00[a]	.055	.085	.06[h]	.09[h]	.....	.078	.....
New York	.....	68.00	2.70	12.50	17.50	.05[b]	.075	.055[h]	.085[h]	.....	.07	.10
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06[h]	.09[h]	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	14.00	19.00	.055	.085	.06[h]	.09[h]	.035	.08	.12
San Francisco	.....	70.00	.....	6.50	15.00	6.50[g]	15.00[g]	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00[c]	.....	13.75	23.55	.....	25.15[g]	10.15/11.15	23.65/24.65	8.40[g]	.0575[i]	.1308

‡ Delivered. [a] F.o.b. Baton Rouge. [b] Delivered to purchaser's warehouse. [c] 3½x4x8½ in. [d] 2½ in. 6 to 8-lb. treatment. [e] Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. [f] Mexican. [g] Per ton. [h] Per gallon. [i] F.o.b. Martinez.

(Continued on page 104)

MILES of SMILES!

The most contented railroad passenger is the one made most comfortable. Timken Roller Bearings effect comfort for the traveling public such as it never before experienced.

The most contented railroad executive is the one who sees operating costs decline—volume increase. Timken Bearings effect economies, maintain schedules, eliminate hot boxes and old time troubles as never before. This is definitely proven by the highly efficient performance of Timken Roller Bearings, now on most of America's newest streamliners and latest locomotives.

That means Miles of Smiles for everyone.

The soundest dollar for dollar investment the American railroads can make is to equip all rolling stock, old and new—passenger cars, locomotives and freights—with Timken Bearings. Costs come down tremendously—volume shoots up—vastly improved all around operation is the gratifying result. Miles of Smiles for everyone!

NOTICE

Look for the trademark TIMKEN on every bearing, whether buying new equipment, or replacing a Timken Bearing in your automobile, or truck, industrial or farm machinery. That trademark is your assurance of quality.

TIMKEN
RAILWAY ROLLER BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

This advertisement appears in The Saturday Evening Post for September 9th. Miles of Smiles for every manufacturer and user of Timken Bearing Equipped products.

(Continued from page 102)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet b	RIVETS ½-in. structural	WIRE NAILS Base d	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle Bars	Std. Spikes c	Tie Plates c	Track Bolts
Birmingham	$2.10	$1.90	$3.40	$2.40	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	1.90	3.40	2.40	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	1.90	3.40	2.40	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	1.90	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	1.90	3.40	2.40	....	....	....	....	....	....	....	....
Youngstown	....	1.90	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.00‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45a	2.25a	....	....	2.85a	....	....	....	....	....	....	....
Pacific ports	2.70a	2.35a	....	....	2.90a	....	....	....	....	3.00	2.25	....

‡ Delivered. a F.o.b. cars dock. b For rail steel deduct 15c. from billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price: 15 tons or over b New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.14	$2.04	.02½	.10	$21.00	$23.00	$1.70	$1.28	$0.1604	$3.04
Baltimore	3.55	2.70	2.55	.....	.10	21.00	23.00	1.58	1.20	.1496	2.70
Birmingham	2.10a	1.90	1.80	.02½	.10	19.50	21.50	1.68	1.26	.1586	....
Boston	3.85	2.58	2.43	$20 C.L.	.10	20.00	22.00	1.64	1.24	.1550	2.99
Chicago	2.10a	1.90	1.80	.03	.05	18.50	20.50	1.55	1.18	.1460	2.40
Cincinnati	3.48	2.31c	2.16c	.....	.05	20.50	22.50	1.54	1.17	.1451	....
Cleveland	3.58g	1.90	1.80	.02½	.10	20.50	22.50	1.54	1.17	.1460	....
Dallas	4.15	2.80	2.65	.....	.....	25.00	27.00	1.81	1.35	.1712	....
Denver	4.21	3.89	3.74	.....	.....	23.50	25.50	1.85	1.37	.1748	....
Detroit	3.65‡	2.45	2.30	.....	.10	22.50	24.50	1.56	1.19	.1478	2.66
Kansas City	4.03	2.51c	2.36c	.0	.05	18.50	20.50	1.66	1.25	.1577	2.86
Los Angeles	3.50f	2.65	2.50	.02½	.05	23.00	27.50	1.81	1.35	.1712	3.50
Minneapolis	3.80‡	2.23c	2.13c	.0	.10	21.50	24.50	1.68	1.26	.1586	2.73d
Montreal	3.25	2.65	2.55	.....	.....	26.68	29.90	2.99	2.08	.314	3.95
New Orleans	3.90	2.69	2.54	.05	.10	21.50	23.50	1.71	1.29	.1522	2.875
New York	3.75	2.29	2.14	.....	.10	20.50	22.50	1.60	1.22	.1514	2.74
Philadelphia	3.40	2.37	2.22	.....	.....	20.50	22.50	1.59	1.21	.1505	2.72
Pittsburgh	2.10a	1.90	1.80	.02½	.10	21.50	24.50	1.47	1.13	.1388	2.40
St. Louis	3.47	2.04	1.94	.0	.05	20.50	24.00	1.57	1.19	.1487	2.70
San Francisco	3.45	2.50	2.35	.02½	.10	23.50	25.50	1.81	1.35	.1712	3.00
Seattle	2.70e	2.40e	.....	.....	.....	25.50	27.50	1.81	1.35	.1712	2.90e

‡ Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c.; 1 to 5 tons, add 10c.

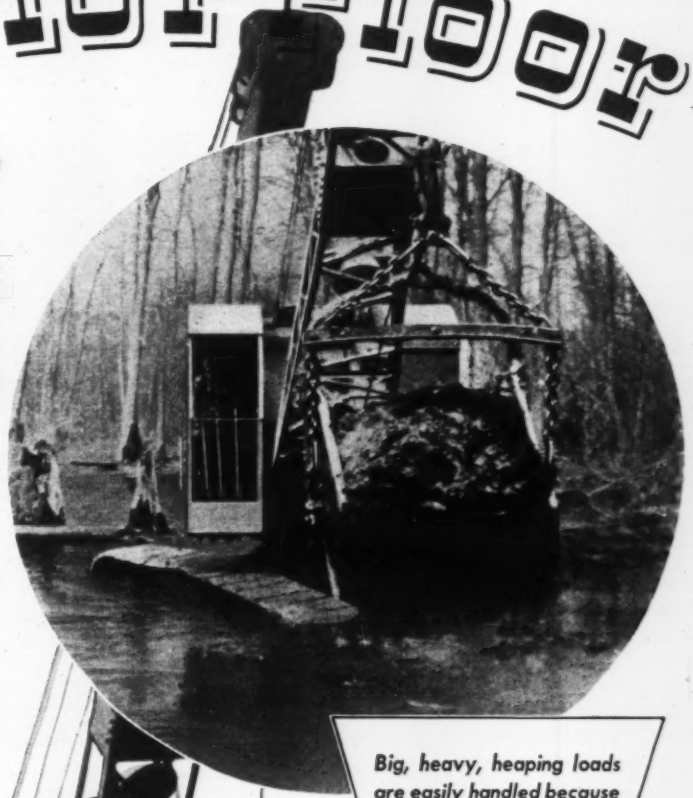
PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE: Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE: Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE: Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE: Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, h: 1 to 3 in., Black %	Galv. %	Butt Weld 3½ to 6 in., Black %	Galv. %	Lap Weld
Atlanta	$46.40	$0.26bc	$0.468bc	$1.8525	$4.68c	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2	
Baltimore	49.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5	
Birmingham	42.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2	
Boston	52.00	.245	.4725	1.98	5.535	166.50‡	240.00‡	.45	2.30	64.1	56.1	61.6	53.1	
Chicago	50.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0	
Cincinnati	49.70	.315	.4725	1.845	5.4325	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9	
Cleveland	51.24	.224	.432	1.665	5.0225	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8	
Dallas	55.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3	
Denver	57.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2	
Detroit	51.24	.147	.2835	1.215	4.70	66.45	111.40	.20	1.125	66.3	58.3	63.8	55.3	
Kansas City	52.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5	
Los Angeles	52.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8	
Minneapolis	54.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2	
Montreal	60.00	.59	.90	3.15	5.10e	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....	
New Orleans	48.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3	
New York	49.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9	
Philadelphia	47.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3	
Pittsburgh	52.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85g	2.00g	68.5i	60.5i	66.0i	57.5i	
St. Louis	49.48	.26	.468	2.016	3.96	85.00	160.00	.80j	2.00k	65.1	57.1	62.0	53.5	
San Francisco	52.00	.3275d	.5895d	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....	
Seattle	52.35	.35	.63	2.52	6.30	72.00	175.00	.45f	1.40f	.....	.....	.....	.....	

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ⅜ in., 8½c.; ½ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. j Reinforced; spec. C 76-37. k Reinforced; spec. C 75-37.

(Continued on page 106)

No Parlor Floor for KOEHRING DRAGLINES



Dragline work on drainage jobs is not done on a "parlor floor". Koehring Dragline crawlers provide stability, have low ground pressure, are controlled from the cab, travel and turn easily, under water, in mud, sand, gravel and under other unfavorable ground conditions. Koehring crawlers need no prepared roadway. Driving tumblers are self-cleaning, without mud traps. Crawler girders protect the rollers. Smooth crawler shoes remain clean. Multiple hinged shoes provide strength across full width connection. Koehring Dragline owners know that their machine can travel where the work is to be done.

Big, heavy, heaping loads are easily handled because of stability, low ground pressure, wide crawlers of Koehring Draglines.

KOEHRING COMPANY
MILWAUKEE • WISCONSIN

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

(Continued from page 104)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) — All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, Rgh	6x12, Rgh	12x12, Rgh	2x12, Rgh	12x12, Rgh	5/16"	1/4"
Atlanta	**$19.00**	**$19.00**	**$18.00**	**$19.00**	**$19.50**	**$21.00**	**$26.00**	.....	.....	**$38.50**	**$52.00**	**$17.75**	$21.60
Baltimore	**24.00**	**25.00**	**24.00**	**25.00**	**26.00**	**27.00**	**39.00**	.....	.....	68.00	70.00	17.35*g*	21.15*g*
	31.00	*31.00*	*31.00*	*31.00*	*31.00*	*31.00*	*39.00*	*$39.00*	*$39.00*	.....	.....	.....	.....
Birmingham	**19.00**	**19.00**	**19.00**	**19.00**	**19.00**	**20.00**	**30.00**	**30.00**	**30.00**	.....	.....	16.25	19.85
	22.00	22.00	26.00	26.00	26.00	36.00	54.00	.....	.....	48.00	53.00	.....	.....
Boston	26.00[2]	26.00[2]	30.00[2]	32.00	48.00[1]	55.00[1]	72.00[1]	.....	.....	72.00	72.00	17.35*g*	21.15*g*
	26.00	*26.00*	*30.00*	*32.00*	*32.00*	*34.00*	*40.00*	*40.00*	*40.00*	.....	.....	.....	.....
Chicago	**29.00**	**30.00**	**30.00**	**31.00**	**32.00**	**31.00**	**45.00**	.....	.....	75.00	80.00	13.15	16.05
	34.00	*35.00*	*34.00*	*35.00*	*36.00*	*35.00*	*40.00*	*40.00*	*40.00*	.....	.....	.....	.....
Cincinnati	**23.75**	**23.75**	**25.00**	**23.50**	**24.50**	**26.50**	**37.50**	.....	.....	46.00	49.50	16.25	19.85
	.....	.....	.....	.....	.....	.....	*39.50*	*39.50*	*39.50*	.....	.....	.....	.....
Cleveland	**30.00**	**30.50**	**30.00**	**30.50**	**32.00**	**34.00**	**41.00**	45.00	45.00	80.00	80.00	16.65	20.25
Dallas *e*	**28.50**	**32.00**	**31.50**	**28.50**	**30.00**	**32.50**	**53.50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	39.00[4]	38.00[4]	39.00[4]	42.00[4]	47.00[4]	41.00[4]	48.00[4]	60.00[4]	71.50[4]	.....	.....	9.90	12.05
Detroit	**28.00**	**28.00**	**29.00**	**28.00**	**31.00**	**34.00**	**37.00**	.....	.....	35.00	48.00	16.25	19.85
	.....	.....	.....	.....	.....	*37.00*	*38.00*	*43.00*	*43.00*	.....	.....	.....	.....
Kansas City	**27.00**	**28.50**	**28.00**	**26.00**	**28.00**	**30.00**	**35.00**	.....	.....	55.00	58.00	12.25	14.95
	28.00	*28.00*	*28.00*	*28.00*	*28.00*	*29.00*	*34.00*	*35.00*	*35.00*	.....	.....	.....	.....
Los Angeles *a*	*35.00*	*35.00*	*35.00*	*35.00*	*36.00*	*36.00*	*42.00*	*46.00*	*42.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis ‡*b*	43.00[5]	43.00[5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*34.00*	*34.00*	*35.00*	*35.00*	*35.00*	*35.00*	*55.00*	*55.00*	*55.00*	.....	.....	.....	.....
Montreal [7]	*44.00*	*44.00*	*49.00*	*47.00*	48.00	58.00	84.00	.....	.....	135.00	145.00	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.00*	*41.00*	*40.00*	*39.00*	.....	.....	.....	.....
New Orleans	**22.00**	**22.00**	**20.00**	**19.00**	**20.00**	**22.00**	**42.00**	.....	.....	58.00	65.00	13.90	16.95
	26.00	*26.00*	*28.00*	*29.00*	*32.00*	*30.00*	*32.00*	.....	.....	.....	.....	.....	.....
New York ‡	**36.00**	**37.00**	**35.00**	**36.00**	**36.00**	**37.00**	**42.00**	.....	.....	77.50*f*	80.00*f*	17.35*g*	21.15*g*
‡	.....	.....	*40.00*	*40.00*	*40.00*	*40.00*	*40.00*	*42.50*	*42.50*	.....	.....	.....	.....
Philadelphia	**23.50**	**24.00**	**25.00**	**25.00**	**26.00**	**26.50**	**28.50**	.....	.....	54.00	56.00	17.35*g*	21.15*g*
	34.00	*35.50*	*38.00*	*37.25*	*36.50*	*36.50*	*41.75*	*31.50*	*31.50*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡*c*	**31.00**	**32.50**	**30.00**	**29.00**	**30.00**	**31.00**	**46.00**	*51.00*	*51.00*	72.00	71.00	13.90	16.95
San Francisco *d*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*23.00*	*23.00*	*23.00*	.....	.....	7.30*g*	8.90*g*
Seattle	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*25.00*	*25.00*	*25.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/16", $74.00; on 3/4", $81.50; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928 — Single or Double Thickness — A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%*d*	75%*d*	$0.15
Baltimore	83%*d*	82%*d*	.15
Birmingham	89%	90%	.105
Boston	82%*d*	82%*d*	.15
Chicago	79%*d*	79%*d*	.15
Cincinnati	79-10%*d*	79-10%*d*	.15
Cleveland	79-10%	79-10%	.19
Dallas	80%*d*	80%*d*	.165
Denver	76-10%*d*	76-10%*d*	.15*e*
Detroit	79-10%*d*	79-10%*d*	.15
Kansas City	79-10%*d*	79-10%*d*	.155
Los Angeles	88%*a*	90%*a*	.1575
Minneapolis	76%*d*	76%*d*	.155
Montreal	70-10%*b*		.17†
New Orleans	80%*d*	80%*a*	.16
New York	82%*d*	83%*d*	.20*f*
Philadelphia	89-10%	90-10%	.15
Pittsburgh	79%*a*	79%*a*	.1425
St. Louis	79-10%*d*	79-10%*d*	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	85%	88%	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb higher than 40%

a Disc. from list Sept. 15, 1938 *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla	.11 -.12	.135 -.15	.155 -.17
Rocky Mtn. States	.11 -.1325	.13 -.145**	.15 -.165**
Pacific N. W. States	.1075-.115	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1175	.135 -.1475	.155 -.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6″ x8″ x8′ Untr.	6″ x8″ x8′ Tr.	7″ x 9″ x8′6″ Untr.	7″ x 9″ x8′6″ Tr.
Boston	Oak	$1.10	....	$1.60	....
	Pine	1.40	$2.10*a*	2.10	$3.00*a*
New York	S. L. Sap Pine	1.05/1.15	1.80	1.45	2.35
	Mixed Oak	1.35	1.90	1.85	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.00	....	1.43	....
	Red Oak	1.00	1.50*a*	1.43	1.98*a*
	Sap Pine or Cypress	.90	....	1.33	....
San Francisco	Douglas Fir	.80*bef*	....	....	1.85*ef*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6″ x 8″ x 8′6″. *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00-2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00-35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.25

(Continued on page 108)

Boone, Iowa, Merchants Salvage Old Street with a CONCRETE RESURFACE

For low annual pavement cost select a concrete design adapted to your traffic conditions.

Cross-section of concrete resurfacing. Note the 10-ft. parking lane tapers from 5 in. to 4 in. thickness to maintain curb height.

As it looked in 1939—Six blocks of Story St., Boone, Iowa, were resurfaced with concrete in 1937. Worn-out topping was removed and new 5-in. slab was placed over the old 5-in. base in 4 longitudinal sections—10, 15, 15 and 10-ft. Bemis & Schlick of Des Moines, Contractors. George Nelson, City Engineer.

FIVE inches of concrete resurface—that was the way Boone, Iowa, salvaged the old concrete base on Story Street and combined its remaining beam strength into a new pavement of adequate load-carrying capacity.

Downtown merchants were glad to foot the entire bill through assessments on abutting property. And little wonder! They got a "bargain"—a lasting pavement inviting to farm trade . . . safe, smooth-riding, easy-to-keep-clean . . . economical to maintain and low in first cost.

Years of experience show that it may be most practical and economical to salvage old pavements with concrete. Concrete resurface may be the best answer to your problem. Design and construction details are described in booklet, *"Salvaging Old Pavements with Concrete,"* mailed free on request (within the U. S. or Canada).

PORTLAND CEMENT ASSOCIATION, Dept. A11d-17, 33 W. Grand Ave., Chicago, Ill.

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work.

(Continued from page 106)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.00	14.00	2.45*m*
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	8.00*o*	1.75*o*	2.25*p*
Boston	90.95*ab*	96.95*ab*	181.80*ak*	206.05*ab*	276.65*ab*	316.15*a*	17.00*i*	20.00*i*	20.00	13.00	2.65*p*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.80*j*	14.00*j*	2.75*jm*
Dallas	62.50	67.50	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis*	.....	.....	.....	.....	.....	.....	13.10	15.10*g*	21.00	16.00	19.00
Montreal	64.00*a*	77.00*a*	141.00*al*	77.00*a*	128.00*a*	.....	21.00	31.00	24.00	15.50	1.75*lo*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30*h*	238.80*h*	295.60*h*	13.50	.....	20.00	14.00	18.00
Philadelphia	77.40	82.50	154.50	185.70	229.90	284.60	11.00*s*	18.00*s*	15.50*q*	10.05	10.55
Pittsburgh	58.40	62.40	116.85	124.00*i*	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12. *No September price available

PAINT, ROOFING—F.O.B. CARLOAD LOTS

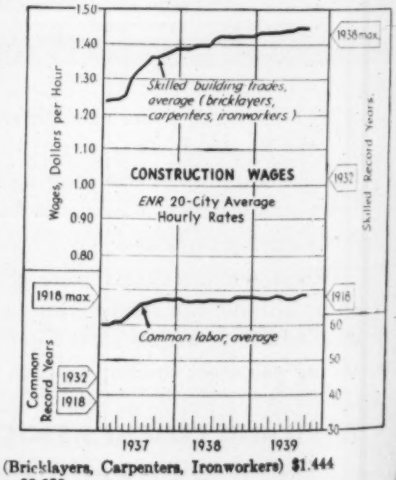
	RED LEAD Per 100 lb. in. 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.00	$12.625	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	8.75	12.25	1.60	2.40	1.90	2.16	2.75	2.75	.40	27.50
Birmingham	9.00	12.625	2.35	2.35	1.85	1.84	1.73	1.73	.45	27.00
Boston	8.75	12.25	1.70‡	2.20‡	1.75‡	1.60‡	1.70*h*‡	1.70*h*‡	.40‡	19.00‡
Chicago	8.75	12.25	1.88	2.53	1.56	1.40*hf*	1.53*hf*	1.53*hf*	.26*f*	21.00*f*
Cincinnati	8.75	12.25	1.45	2.50	1.40	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.75	12.25	1.90	2.60	1.40	1.50	1.50*h*	1.50*h*	.35	21.00
Dallas	8.75	13.00	1.80	1.95	....	2.75*h*	2.50*h*	2.50*h*	.60	....
Denver	9.25	12.75	....	....	....	2.45	4.00	3.00	.35	18.00
Detroit	8.75	12.25	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	8.75	12.375	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	9.00	12.75	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	8.75	12.375	....	....	....	1.50*i*	1.50*hi*	1.50*hi*	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	3.05	1.85	2.15	.95	10.80*k*
New York	8.75	12.25	1.80	2.45	1.48	1.58	1.45*h*	1.45*h*	.23	24.00
Philadelphia	8.75	12.25	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	8.75	12.25	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.75	12.25	1.70/1.90	2.50/2.75	1.50/1.90	1.50	1.40	1.35	.23	21.00
San Francisco	9.00	12.50	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.00	12.75	1.80	3.00	2.20	2.35	1.46/2.14	1.95	.63	24.75*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* 550 lb. barrel.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.375/1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.00	1.00	1.25	1.00	1.00	.40	.40
New York	1.90*b*	1.75*b*	1.925	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65	1.25	1.50	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.91	.65
Seattle	1.60*cc*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) **$1.444**
ENR Common Average: $0.685